PROJECTED FY97

SMALL BUSINESS INNOVATIVE RESEARCH TOPICS

AERONAUTICAL SYSTEMS CENTER

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FOREWORD

Enclosed are the Aeronautical Systems Center's FY97 Small Business Innovation Research (SBIR) topics for Wright Patterson AFB OH and Eglin AFB FL. The topics will appear in the DoD Solicitation FY97.1 that opens on or about 1 October 1996. The purpose of this document is to provide small businesses with an advance copy of ASC's SBIR requirements. It also provides you with an opportunity to discuss the technical aspects of these requirements with the point of contact for the sponsoring organization. It is anticipated that the additional insight will assist your company in preparing more competitive technical proposal(s). Inasmuch as the points of contact e-mail addresses are incomplete, you are advised to make initial contact by telephone. Both topic number and topic content may change when the solicitation is issued; accordingly, you are advised to read very carefully those topics in the solicitation in which you are interested.

NOTE: NO DISCUSSIONS MAY BE HELD WITH THE POINT OF CONTACT AFTER 30 SEPTEMBER 1996.

AF97-114 thru 97-139	Avionics Directorate WL/AAOP, Bldg 620 2241 Avionics Circle Wright-Patterson AFB OH 45433-7318 (Sharon Gibbons (513) 255-5285)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143
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AF97-174 thru 97-191	Aeropropulsion Directorate WL/POM, Bldg 18 1950 Fifth Street, Room 105A Wright-Patterson AFB OH 45433-7251 (Betty Siferd (513) 255-2131)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143
AF97-192 thru 97-198	Manufacturing Technology Directorate WL/MTX, Bldg 653 2977 P Street, Ste 6 Wright-Patterson AFB OH 45433-7739 (Marvin Gale (513) 255-4623)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143
AF97-199 thru 97-218	Armament Directorate WL/MNPB 101 West Eglin Blvd, Ste 143 Eglin AFB FL 32542 (Richard Bixby (904) 882-8591)	Lyle Crews, Jr. (904) 882-4284
AF97-251 thru 97-254	Development Planning Directorate ASC/XRP, Bldg 16 2275 D. Street, Ste 10 Wright-Patterson AFB OH 45433-7227 (Lt Col Azeez Shamoyeh (513) 255-2630, ext. 3079)	Annette Long (513) 255-6632

AF97-114 TITLE: <u>Precision Reference Information State Error Measurement (PRISEM)</u>

OBJECTIVE: Develop real-time techniques for qualitatively characterizing reference systems state vector quality.

DESCRIPTION: Current and future military operational concepts emphasize the use of multi-platform operations and the sharing of resources within the theater of operations. This capability would allow many more users access to data from expensive resources and in some cases would help extend the operationally beneficial life of certain aging airframes. However, before the concepts for sharing such resources are operationally feasible, many technical issues must be resolved. Of particular interest and technical challenge are issues related to the processing and sharing of reference systems information (position, velocity, attitude, and pointing information from, to, and regarding the ownship, other friendlies, enemy operations, and targets). This research is intended to develop a capability to assess the quality of the reference state vectors used in the fusion process. These state vectors are generated by the reference system on each platform that provides or uses the information. The state vector information must be translated to each mission sensor on the information providing platforms. The real-time state vector quality assessment must provide both the quantitative and symbolic measures required to enhance the various levels of information and sensor fusion ranging from intraplatform to interplatform. These measures will range from probability distribution characterization to fuzzy sets, depending upon the fusion algorithms being supported. Technology that would enable consistently representing and reflecting the impact of characteristics of the reference systems data upon platform subsystems dependent upon that data would provide a capability to support theater-wide information fusion with predictable and reliable results. Assessment of technologies developed will be performed using such metrics as targeting error, errors indetecting and discriminating targets and threats, and computational improvements in fusion algorithms. Potential sources of data include E-3As/AWACS, E-8s/JSTARS, national assets, UAVs, reconnaissance platforms, and combat aircraft. Potential users of the information include combat aircraft, special operations aircraft, transport aircraft, ground based systems and personnel, ships missiles, and C2 nodes.

PHASE I: Using requirements determined under previous Theater-wide Reference Information Management programs (IMTRS, CORF, TRIM), Phase I of the Precision Reference Information State Error Measurement (PRISEM) program will consist of an assessment of current techniques for characterizing reference systems data and approaches to performing information fusion using that characterization to provide stability and coherence

to the fusion process. Through the use of analysis and simulation, an assessment will then be performed of the applicability of various technologies to developing a coherent approach to this characterization and the sharing and using of that characterization by the gamut of levels of fusion required in the theater-wide environment. Potential technologies include modern estimation theory, symbolic reasoning, neural processing, and/or fuzzy processing.

PHASE II: Develop techniques, algorithms, and data structures using the applicable technologies identified under Phase I to produce real-time characterizations of reference state vectors. This demonstration system will consist of models of the sources and users of the information, and the information content of all data transmissions that would take place during a specific, realistic mission scenario. Other pertinent functions of the developed technology include error detection and system compensation.

POTENTIAL COMMERCIAL MARKET: Dual use applications include any process requiring correlation of information from disparate sources, each having its own degree of precision and reliability and its own approach for representing the quality of that information. Potential application areas would include those requiring immediate determination of "situation awareness" such as transportation, environmental or natural disaster monitoring, medical emergencies, dynamic business operations, and complex manufacturing or chemical processes involving multiple sources of instrumentation and observation for which fault elimination is of critical importance.

REFERENCES:

1. Berning S., Howe P., Jenkins, T. "Theater-Wide Reference Information Management," Proceedings of The National Aerospace and Electronics Conference (NAECON) 1996.

To obtain this reference, contact Sandra Berning at (513) 255-2305.

END OF TOPIC

POINT OF CONTACT: Sandra Berning, (513) 255-2305, berningsl@aa.w

AF97-115 TITLE: Automatic Target Recognition (ATR) Technology Components

OBJECTIVE: Develop new and innovative techniques for ATR algorithm design and performance evaluation.

DESCRIPTION: The Air Force is actively pursuing ATR technology for various reconnaissance and weapon delivery scenarios. Typical application scenarios demand robust approaches due to high clutter terrain environments or extensive use of camouflage and concealment or stealth. The Air Force is interested in new approaches to performing automatic target recognition with a variety of sensor modalities, examples of which include (but are not limited to) Synthetic Aperture Radar (SAR), Electro-Optic (EO) and Infra-Red sensors, 1D High Range Resolution (HRR) Radar-Frequency (RF) and laser sensors, and 3D laser radar or other 3D scanning sensors. Note that approaches which support fusion of sensor information across any or all of the above sensor modalities and with nonsensor data such as digital maps or object behavior models are highly desired, but not required. Examples of ATR technology components that are of interest include model and Physics-based, evolutionary computing, and behavior-based techniques. To promote understanding for potential respondents, a short explanation of these technology components are given below. Note that these are only examples, and any concept that shows promise for robust, adaptive ATR with remotely sensed data will be considered responsive to this topic solicitation. In addition to techniques for development of ATR algorithms, new and innovative approaches to improve existing ATR evaluation methodologies and tools, including both analytical and experimental approaches are also sought.

Model and Physics-based ATR - techniques that make explicit use of target object geometry models and/or the physics of the image or sensed data formation process. This could include explicit models of the 3D world-to-sensed data geometric transformation, the emitted or scattered radiation from the target object(s) and how this energy is sensed and processed to form the sensor output. Such approaches often include matching of predicted features to features extracted from sensed data.

Evolutionary Computing - this is characterized by a performance-driven selection process and a population of elements that undergoes reproduction with variation, in a manner similar to natural evolution. The motivation is to endow the computer with a capability to synthesize nonintuitive solutions to problems with minimal or no human interaction (other than in setting up the process). Key elements include a comprehensive representation domain for the problem, an intelligent search strategy and a performance evaluation methodology. Techniques

which automatically or semi-automatically generate feature detectors or other algorithm components to create new pattern recognition systems are desired.

Behavior-based ATR - Behavior recognition can supply possible hypotheses for ATR that are not apparent from a direct analysis of the sensor information. Inferring the possible intent of a group of vehicles may often be the key to their identification, where purely visual-like processes may face difficulties. As examples, in air-to-air combat tracking the possibly threatening maneuvers of a group of aircraft may be the key to recognizing them as targets, or a vehicle that exhibits no unique sensor signature but moves in a particular fashion could be identified as a mobile missile launcher, but not otherwise.

WL/AAC has been supporting the KHORUS environment, which is a public-domain software environment for image and signal processing. KHORUS is the AAC preferred environment for developing ATR algorithms and evaluation techniques, and its use would greatly enhance the potential for Air Force application of any ATR research conducted under this solicitation. For more information, see the MBVLab WWW page - http://www.mbvlab.wpafb.af.mil/

PHASE I: Determination of ATR algorithm design or performance evaluation concept feasibility.

PHASE II: Development of dual-use ATR algorithm design or performance evaluation technique.

POTENTIAL COMMERCIAL MARKET: Object recognition technology is applicable to a wide array of commercial areas including vehicle navigation, security monitoring, industrial inspection, manufacturing automation, and satellite-based earth resource monitoring.

REFERENCES:

1. ATR Performance Evaluation - W. Eric Grimson, "The Combinatorics of Heuristic Search Termination for Object Recognition in Cluttered Environments," IEEE PAMI Trans, Sep 1991.
2. Physics-Based ATR - R. Kapoor and N. Nandhakumar, "A Physics-Based Approach for Detecting Man-Made Objects in Ultra-wideband SRA Imagery," Proc. IEEE Workshop on Physics-Based Modeling in Computer Vision. IEEE Computer Society Press, 1995.
3. Evolutionary Computing - L. A. Tamburino,

END OF TOPIC

POINT OF CONTACT: Vince Velten, (513) 255-1115, veltenvj@aa.wpaf

AF97-116 TITLE: Sensor Management Across Multiple Platforms (SMAMPS)

OBJECTIVE: Develop methodologies for on-board sensor managers to work cooperatively across platforms.

DESCRIPTION: Presently, there is on going research to determine multi-platform resource sharing through Cooperative Research And Development Agreement (CRADA) between the Avionics Directorate and Lockheed Fort Worth. This work is determining the feasibility, merit, and means of obtaining and using shared resources among multiple platforms to enhance tactical aircraft effectiveness. In addition to the CRADA work, research must be performed on the development of on-board sensor managers that will take advantage of the shared resources. This effort will investigate methodologies for managing sensors taking into account cooperative resources from multiple platforms within the same formation. The issues involved include resource control across aircraft, coordination of functions, and alignment challenges. The major function of the sensor manager is to supply useful data to the pilot; therefore, issues such as data formats, data latency, size of data shared, and accuracy of the data will be investigated. A major difficulty will be timing aspects which may utilize the high accuracy clock signals from GPS. Another aspect of a shared sensor manager is the data links necessary. This program will examine if present or proposed data links will provide the cooperative functions necessary, the actual development of a data link is out of the scope of this program. It is envisioned that some of the missions multi-platform sensor management can support are cooperative search, tracking, and identification. Multi-platform sensor management could also utilize active sensors on one platform to keep another platform covert. The sharing of information from different sensors across platforms will decrease costs of aircraft, utilize aircraft covertness, and provide sharing of important information.

PHASE I: Determine the issues involved in developing a cooperative sensor manager. Develop preliminary techniques to solve the major problems with sensor management across multiple platforms.

PHASE II: Develop the techniques further. Design a cooperative sensor manager, utilizing these techniques, and test this system through simulation with the intention of incorporating into major platform avionics.

POTENTIAL COMMERCIAL MARKET: The manufacturing industry will use the resource allocation methods in production planning and scheduling. These technologies are especially useful in manufacturing for automated multistep processes which use sensors to determine positioning, defects and other factors. Resource allocation problems for R&D projects having multiple,

competing objectives in an uncertain environment is another dual use for this technology. Cellular phone technology can use some distributed technologies for emergency location systems. The automotive industry is an especially attractive dual use for this technology. The automobile manufacturers are being pushed to develop sensor management technologies with new car developments such as computer controls, GPS, onboard maps, and other intelligent features. Also, the technologies for sensor allocation and scheduling, and information sharing across multiple platforms will be a critical item for the Intelligent Vehicle Highway System being developed.

REFERENCES:
1. J. Diemunsch, "Wright Laboratory Sensor Management Efforts," 9th National Symposium on Sensor Fusion, 1996.
2. W. Bryan Bell, Multi-Path Resource Sharing CRADA Report, Advanced Mission Concepts, Lockheed-Fort Worth Company.

These references and additional references available by contacting Joe Diemunsch at (513) 255-4952.

END OF TOPIC

POINT OF CONTACT: Joe Diemunsch, (513) 255-4952, diemunjr@aa.wpa

AF97-117 TITLE: <u>Avionics Applications of Reinforcement Learning Systems</u>

OBJECTIVE: Develop methods to use reinforcement learning systems, utilizing residual algorithms, for the control and allocation of sensor resources.

DESCRIPTION: Utilize a residual reinforcement learning system to optimally manage/allocate sensor resources. The system is to be embedded in an airborne platform with a standard suite of sensor resources. Based on situational circumstances, the reinforcement learning system should learn the optimal allocation of sensor resources for the purpose of target identification. For example, the reinforcement learning system might control a low resolution sensor with a wide field of view for the detection of objects that might require further investigation. After detection, the reinforcement learning system should then position a high resolution sensor with a narrow field of view on these objects for the purpose of identification. Determine the scientific and technical feasibility of this approach, through analysis and simulation. Identify the possibilities of this approach for dual-use application to civilian problems.

PHASE I: Determine the scientific or technical merit and feasibility of the application of residual reinforcement learning to avionics sensor resource management/allocation.

PHASE II: Develop a product/process that utilizes residual reinforcement learning systems to optimally manage/allocate sensor resources.

POTENTIAL COMMERCIAL MARKET: The systems developed will be applicable to avionics problems in civilian aviation, and may be applicable to other optimal control and decision-making problems such as sensor management in cars or factories. For example, the automobile industry has an interest in robots that can perform more than a single function. The robot would decide the function to perform based on the object at hand. The process of object recognition and identification requires intelligent allocation of sensor resources. Another example of commercialization potential is in the home and business security industry. Security systems that utilize vision systems require the detection and identification of objects/people, and might use more than a single type of sensor. The technology developed in this SBIR would be directly applicable to foveal machine vision systems that are used in such security systems, as well as all other foveal machine vision applications.

REFERENCES:

1. Baird, L. C. (1995). Residual Algorithms: Reinforcement Learning with Function Approximation. In Armand Prieditis & Stuart Russell, eds. Machine Learning: Proceedings of the

Twelfth International Conference, 9-12 July, Morgan Kaufman Publishers, San Francisco, CA.
2. Harmon, M.E., Baird, L.C., & Klopf, A.H. (1996) Reinforcement learning applied to a differential game. Adaptive Behavior, 4(1), 3-28.

These references and additional references available via World-Wide-Web: http://www.aa.wpafb.af.mil/~harmonme/

END OF TOPIC

POINT OF CONTACT: Mance Harmon, (513) 255-7643, harmonme@aa.wpaf

AF97-118 TITLE: Multiple Target Tracking for Avionics Platforms

OBJECTIVE: Develop technologies to enhance avionics multiple target detection and tracking performance by sharing information between platforms.

DESCRIPTION: Innovative digital signal and image processing technologies which can be used to enhance the ability of Air Force avionics platforms ability to detect and track multiple targets are being sought. Some fighter aircraft systems share track file information between different platforms but better performance might be achieved by sharing detection information from sensors at different geometries and with different spectrum. This may particularly be true in scenarios where high false alarm rates occur because of low signal-to-noise ratios or ground clutter. The obvious approach of centralized fusion is impractical because of communication bandwidth requirements. Innovative approaches are needed which minimize communication requirements. The response should lead to significant improvements in one of the following areas where false alarms are a significant problem: detecting and tracking low signal-to-noise targets (detection false alarm rate - improve by 30% and tracking range - improve by 20%) e.g., F-16's tracking cruise missiles and tracking targets in clutter (improve false alarm rate by 30%) e.g., F-15 tracking low flying aircraft. The technology should be applicable to avionics sensors in development or on operational aircraft. This includes either active or passive sensors such as RADAR and Electro-Optical sensors.

PHASE I: As needed, reduce risk of proposed technology obtaining stated goals by developing necessary mathmatics and/or performing feasibility analysis. Make an initial assessment of implementation and trade-off issues. For instance, more fully develop the mathematical basis for an approach which reduces false alarms by fuzing detection data from multiple platforms. Analyze the on-board and off-board communication requirements for such an approach. Consider impact of alternatives. Develop the Phase II technology demonstration approach.

PHASE II: Demonstrate that the proposed technology can obtain stated improvements.

POTENTIAL COMMERCIAL MARKET: Potential application areas are distributed process-control systems used for vehicle and air traffic control.

REFERENCES:
1. Bar-Shalom and Fortmann, Tracking and Data Assocation, Academic Press, Inc., 1988.
2. Bar-Shalom and Li, Estimation and Tracking: Principles.

Techniques and Software, Artech House, Inc., 1993.

END OF TOPIC

POINT OF CONTACT: Devert Wicker, (513) 255-3510, wickerdw@aa.wpa

AF97-119 TITLE: Biological and Cognitive Foundations of Holistic Information Fusion

OBJECTIVE: Develop methods to employ Biological and Cognitive Sciences concepts to develop general-purpose, holistic information fusion algorithms and architectures.

DESCRIPTION: Information Fusion (a.k.a. Sensor/Data Fusion) is loosely defined as the process by which noise-corrupted data (potentially from disparate sources) is gathered, combined, reasoned-over, and new resource allocation decisions are made. In dynamic, uncertain, and high-stress warfare environments, information fusion is a formidable task--the dimensionality of the space of states and actions makes a comprehensive solution untenable for most realistic problems. Instead, the system designer typically invokes one of the fundamental tenets of systems engineering which we shall call "Divide and Conquer": A single, complex process is separated into subprocesses which are then solved independently. For information fusion systems this means that a single large, interrelated process involving gathering data (sensing), filtering data (kinematic and ID estimation), assessing situations, and deciding upon new information-effecting actions is separated into distinct sub-processes with predefined interfaces. Unfortunately, this approach can lead to suboptimal performance resulting from the requirement to contend with complex interactions between the subprocesses. Further, significant computational and communication burdens can be incurred by ensuring that the subprocess interfaces are robust enough to account for all of the complex interactions. Taken together, these problems work to limit the types of information a working system can accommodate. Presumably, the benefits of a holistic approach would include more robust performance with more efficient use of communication/computation assets. This would enable a wide variety of information, including sensor readings, contextual information, and pilot assessments, to be integrated into a single computational framework. Such an approach could also impact attempts to formulate a general-purpose information fusion processing model which currently does not exist.

This effort shall seek to broaden the technology base for intelligent information fusion systems by leveraging theoretical results from the biological and cognitive sciences toward developing a holistic, robust information fusion algorithm/architecture (algotecture). In the past, efforts to develop intelligent systems based upon biologically-inspired concepts have led to significant advances and new paradigms (such as reinforcement learning, various types of neural networks, generic algorithms, etc.). These continue to be fruitfully exploited by the research community. The vision of this work is to develop novel, biologically-inspired paradigms

for holistic information fusion systems with comparable utility.

PHASE I: Under the first phase of this research, the contractor would develop a theoretical approach to holistically address the information fusion challenge in the most robust and efficient manner possible. The basis for the paradigms developed shall be inspired from biological and cognitive theories/models. These paradigms may be developed by reworking existing biologically-inspired models, or completely new models may be developed for this effort. The contractor would conduct simulation-based research to evaluate trade-offs between various paradigms. The specific information fusion problem to be addressed should reflect the environment of a tactical fighter in a high-stress situation. General details shall be decided upon by mutual concurrence at the kickoff meeting.

PHASE II: Under the second phase of this work, the contractor shall perform studies to evaluate theoretical and implementation trade-offs for the paradigm(s) developed under Phase I. The simulations used shall be of higher-fidelity than those used in Phase I.

POTENTIAL COMMERCIAL MARKET: The proposed effort will extend the theoretical foundations of information fusion. Since this research proposes to impact information fusion technology at a fundamental level, it is more likely to have a far-reaching effect. Aside from DOD applications involving military aircraft, ground and sea warfare, a variety of non-DOD applications are also envisioned; these include robotics, traffic control systems, industrial planning and control, flexible manufacturing, financial planning, and the "information superhighway."

REFERENCES:
1. E. Waltz, J. Llinas, MultiSensor Data Fusion, Artech House, Norwood, MA 1990
2. R. C. Luo and M.G. Kay, "Multisensor Integration and Fusion in Intelligent Systems," IEEE Trans. Syst. Man, Cyber., vol 19, no. 5, pp. 901-931, Sept./Oct. 1989
3. R.R. Murphy, "Biological and Cognitive Foundations of Intelligent Sensor Fusion," IEEE Trans. Syst. Man, Cyber., vol 26, no.

END OF TOPIC

POINT OF CONTACT: Raj Malhotra, (513) 255-3765, malhotrp@aa.wpaf

AF97-120 TITLE: Solid State RF Electronics Applied Research

OBJECTIVE: Explore innovative RF device and component technologies, and demonstrate concept feasibility.

DESCRIPTION: Investigate promising new microwave and millimeter wave circuit and component technologies with the potential to reduce the cost, weight, and volume, and increase the reliability/performance of military RF systems. Candidate technologies include microwave and millimeter wave solid-state and vacuum electronic devices, monolithic integrated circuits, computer aided design/characterization techniques, device and circuit fabrication, power and low noise amplifiers, signal control components, and mixed mode ICs. Emphasis will be placed on the development of technologies which reduce size, weight and cost through improved fabrication and higher levels of integration, and which are amenable to accurate modeling for improved design and simulation.

PHASE I: Determine the initial feasibility of the concept through design, physical analysis, mathematical modeling and analysis.

PHASE II: Develop key processes, validate the model experimentally, explore critical parameters, and optimize the design.

POTENTIAL COMMERCIAL MARKET: Commercial applications that will benefit from innovative electron device technological advancements include high temperature RF transmitters and mixed mode ICs for personal communications, and automotive collision avoidance/warning, and radiometric sensors for the medical industry.

REFERENCES:
1. D. Hill, A. Khatibzadeh, W. Liu, T. Kim, P. Ikalainen, "Novel HBT with Reduced Thermal Impedance," Microwave and Guided Wave Letters, Vol. 5, No. 11, Nov 1995.
2. B. Bayraktaroglu, J. Barrette, L. Kehias, C.I. Huang, R. Fitch, R. Heidhard, R. Scherer, "Very High Power Density CW Operation of GaAs/AlGaAs Microwave Heterojunction Bipolar Transistors," IEEE Electron Dev. Lett., Vol 114, No. 10, Oct 1993.

END OF TOPIC

POINT OF CONTACT: Mark Calcatera, (513) 255-7679, calcatmc@aa.wp

AF97-121 TITLE: Innovative Molecular Beam Epitaxy (MBE) Growth and Semiconductor Characterization Components and Techniques

OBJECTIVE: Develop components and techniques to enhance the growth capability and understanding of MBE

DESCRIPTION: This effort will involve the ability to improve MBE semiconductor crystal growth capability by the design of innovative crystal growth and/or characterization components and techniques. These innovative components or techniques may either fit directly on an MBE machine, as in an effusion source, or support the MBE system in material characterization, as would a scanning tunneling microscope. The characterization may be either optical and/or electrical in nature. If the component is to go directly onto the MBE, it must fit on a Varian (GEN II-like system). The component or technique must emphasize nitride (wide bandgap) or antimonide (narrow bandgap) based III-V semiconductors.

PHASE I: Emphasis will be on the design and prototyping of the component or technique to determine feasibility.

PHASE II: Emphasis will be on the fabrication of the innovative component or technique with a demonstration of the capability and delivery to the Air Force.

POTENTIAL COMMERCIAL MARKET: Potential applications would be the growth, characterization and development of heterostructure lasers, microwave and millimeter wave transistors, infrared detectors and high temperature electronic components. Potential users would be military and commercial component vendors; MBE manufacturers: EPI, SVT and MBE machine users: Defense contractors (TRW, Hughes, Raytheon and TI), Government Labs (WL, ARL, NRL, NIST) and Commercial companies (HP, AT&T and Bellcore).

REFERENCES:
1. K.R. Evans, R. Kaspi, J.E. Ehret, M. Skowronski, and C.R. Jones, J. Vac. Sci. Tech. B, 13 1820 (1995).
2. J.F. Zheng, J.D. Walker, M.B. Selmeron and E.R. Weber, Phys. Rev. Lett. 72, 2414 (1994).

END OF TOPIC

POINT OF CONTACT: Chern Huang, (513) 255-2227, huangci@aa.wpafb.

AF97-122 TITLE: Innovative Electro-Optic Device Technology

OBJECTIVE: Develop electro-optic device technologies which offer expanded or new electronic functionality and/or improvement of electro-optical sensor capabilities.

DESCRIPTION: To meet the stated needs for future Air Force systems, further development of electro-optical component performance and functionality is required. Not only are these needs stated in terms of increased or new operational specifications, but there is also an expressed emphasis on achieving this performance at the lowest possible cost. The objective of this topic is to develop new and/or improved materials, devices, small to medium scale integrated circuits, and/or models or concepts which address: (1) detector or focal plane array sensors, expecially in the ultraviolet and infrared spectral regions; (2) focal plane array sensor readout/multiplexer circuitry to allow increased signal processing at the focal plane array itself; (3) low power light emitters/lasers for integrated circuit optical interconnect and associated applications; (4) optical switching devices, directional couplers, and related concepts; (5) modulation control devices and techniques, especially for microwave frequencies; and (6) other electro-optic techniques for increasing the speed, reducing the cost, size, and weight of icrowave/millimeter-wave or high speed digital electronics and integrated circuits which enhance current electronic functions.

PHASE I: Determine the initial feasibility of the concept through design, physical analysis, mathematical modeling, crystal growth, preliminary device fabrication and/or measurements.

PHASE II: Develop key processes, validate the model/device experimentally, explore critical parameters, optimize design, and fabricate demonstration devices, circuits, or interconnects.

POTENTIAL COMMERCIAL MARKET: Commercial applications that will benefit from innovative electro-optic device technological advancements include: (1) optical sensors for applications such as environmental monitoring and night vision; (2) high speed elctronics for computers and communication systems; and (3) diagnostic tools for the medical industry such as thermal imaging and miniaturized probes.

REFERENCES:

1. D.L. Smith and C. Mailhiot, "Proposal for Strained Type II Superlattice Infrared Detectors," J. Appl. Phys. 62(6) 2545 (1987).

2. R. H. Miles, D. H. Chow, J. N. Schulman, and T.C. McGill, "Optical Properties of InAs/GaInSb Superlattices," Appl. Phys.

Lett. 57, 801 (1990).

END OF TOPIC

POINT OF CONTACT: Charles Stevens, (513) 256-4161, stevensc@el..

AF97-123 TITLE: Support Technologies for Multichip Modules

OBJECTIVE: Develop the support technologies required to produce affordable multichip assemblies.

DESCRIPTION: To meet the ever expanding need for increased functionality in advanced military systems requires the use of advanced IC technologies closely coupled to advanced packaging techniques such as multichip modules, chip on board and three-dimensional packaging. Many of these assemblies contain both analog and digital devices operating in close proximity to one another and must meet stringent size, weight, and power requirements while being able to operate over a wide range of temperatures (-55 degrees C to 125 degrees C). The objective of this topic is to develop the support technologies required to produce affordable multichip assemblies. Areas of interest include, but are not limited to design tools for mixed mode assemblies, including electromagnetic modeling and simulation tools; known good die; low parasitic interconnects, including microwave dielectric materials for three-dimensional packaging; protective coatings; thermal management techniques; testing methods; and improved assembly techniques.

PHASE I: Determine the initial feasibility of the concept through design, physical analysis, mathematical modeling, measurements, and, if possible, a prototype.

PHASE II: Develop key processes, validate models experimentally with hardware, explore critical parameters and optimize the design/assembly.

POTENTIAL COMMERCIAL MARKET: Commercial applications that benefit from innovative packaging technology advancements include high performance digital, analog and mixed mode assemblies such as found in computers, wireless communications, automotive and miniaturized diagnostics for the medical industry.

REFERENCES:

1. R.R. Tammale, "Microelectronic Packaging Handbook," 1989, Van Nostrand Reinhold.
2. Semiconductor Industry Association (SIA) "The National Technology Roadmap for Semiconductors"

END OF TOPIC

POINT OF CONTACT: Frank Lamb, (513) 255-4557, lamb@el.wpafb.af.m

AF97-124 TITLE: Innovative Microelectronics Device Development

OBJECTIVE: Develop innovative semiconductor device technology and demonstrate concept feasibility.

DESCRIPTION: Explore revolutionary new device concepts and conduct feasibility demonstration efforts on devices with potential for high frequency microwave/millimeterwave and high speed electronics applications, e.g., novel ideas for greatly increasing the speed of analog to digital converters with device cutoff frequency greater than 200 GHz and power consumption less than 1 uw/gate. Examine new device approaches to logic and electronic processing, ultrahigh speed digital switching devices and advanced semiconductor fabrication technology. Investigate promising microwave and millimeterwave solid-state devices such as microwave power device with power density greater than 20 mW/um2, monolithic integrated circuits and computer-aided design/fabrication. The intention of this program is to examine new device approaches, including existing devices such as Heterojunction Bipolar Transistors (HBTs), III-V Complementary Heterostructure Field Effect Transistors (C-HFETs), Metal Semiconductor Field Effect Transistors (MESFETs), and other very high performance devices (HEMTs, RTDs, etc.). Consideration will be given both to those technologies that promise reproducible circuits, and to the application of III-V nitride compounds to the device fabrication. Selection of the demonstration vehicles shall be based on customers future needs and the availability of suppliers transferring these technologies from a research to a production environment.

PHASE I: Device concepts, including material growth, characterization, and device development shall be completed, and fabrication feasibility, shall be demonstrated.

PHASE II: Functional demonstration vehicles and design of potential products shall be completed.

POTENTIAL COMMERCIAL MARKET: Commercial applications for low power, high density, high frequency IC technology include mobile communication equipment and networks, high density logic/memory components, and consumer electronics.

REFERENCES:
1. S.C. Binari, "GaN FETs for High Temperature and Microwave Applications," Proceedings of the Symposium on Wide Bandgap Semiconductors and Devices and the 23rd State-of-the-Art Program on Compound Semiconductors, Vol 95-21.
2. Semiconductor Industry Association (SIA) "The National Technology Roadmap for Semiconductors."

END OF TOPIC

POINT OF CONTACT: Kenichi Nakano, (513) 255-4234, nakanok@aa.wpa

AF97-125 TITLE: <u>Adaptive Computing for RF Device and Component Modeling</u>

OBJECTIVE: Investigate innovative RF device and component computer-aided engineering technologies, and demonstrate concept feasibility.

DESCRIPTION: Explore novel microwave/millimeter wave computer-aided engineering technologies. The goal is to achieve a major reduction in the cost of and time required for designing microwave/millimeter wave devices and monolithic integrated circuits. Candidate technologies include, but are not limited to, various computational intelligence methods encompassing: neural networks, fuzzy logic, genetic algorithms, evolutionary programming, and adaptive reasoning systems. Emphasis will be placed on the development of technologies that enhance areas which currently limit the efficiency of the microwave/millimeter wave computer-aided engineering design cycle.

PHASE I: Determine the initial feasibility of the concept through the development of prototype implementations and identification of opportunities for insertions into microwave/millimeter wave computer-aided engineering tools.

PHASE II: Develop and demonstrate prototype by insertion into microwave/millimeter wave computer-aided engineering tool, validate the implementation, identify candidate insertions into mainstream commercial microwave/millimeter wave computer-aided engineering tools to enable broad market access.

POTENTIAL COMMERCIAL MARKET: Commercial applications that will benefit include microwave/millimeter wave computer-aided engineering tools.

REFERENCES:

1. J.M. Zurada, "Introduction to Artificial Neural Systems," West Publishing Co., St. Paul, MN, 1992, pp 186-190.

END OF TOPIC

POINT OF CONTACT: Gregory Creech, (513) 255-7663, creech@el.wpaf

AF97-126 TITLE: Highly Sensitive Imaging Detectors for Laser Radar Systems

OBJECTIVE: Develop highly sensitive imaging detectors for laser radar transceivers that operate at wavelengths longer than 1.4 micrometers.

DESCRIPTION: Laser radar systems have significant potential for imaging and targeting applications. The desire to use such systems to image unknown objects requires that the imaging function be performed at wavelengths that are eye safe; in other words, the wavelength should be longer than 1.4 micrometers. Such wavelengths are beyond the responsibility of typical silicon detectors. It is desired that the detectors operate at a minimum in the wavelength region from 1.5 micrometers to 2.5 micrometers, though operation out to longer wavelengths (5 micrometers) is desired. The detectors must operate uncooled or with moderate cooling at most (no cryogenics). Additional requirements include the ability to gather the entire image on a single pulse from the laser transceiver; therefore, the receiver must contain multiple pixels. Minimum pixel counts would be 32 x 32, with greater than 64 x 64 desired. Another consideration is that the laser radar transceiver will image objects at long ranges, perhaps in excess of 20 kilometers. Because the return signal from objects at such ranges will be extremely small, it is desired that the detectors have some form of gain which would allow them to operate at or near the shot noise limit. A final consideration is to obtain full three-dimensional imagery the detector must be capable of being coupled to readout circuitry that will provide a range counter per pixel. Such circuitry is being developed by Wright Laboratory, WL/AAJT, and is described in the reference listed below. Approaches such as the use of avalanche photodiodes and fiber amplifiers have been considered in the past and are described in the reference below. Extensions of these approaches to single pulse imaging or other approaches that meet the requirements specified here are solicited.

PHASE I: Design and assessment of receiver architecture and critical detector component technologies. The approach to achieving single pulse, highly sensitive imaging of eye-safe laser energy will be defined. Critical issues associated with fabrication of the detector and integration with the appropriate readout circuitry will be defined and approaches to fabrication will be developed.

PHASE II: Fabricate and quantitatively evaluate an eye-safe detector with limited number of pixels. Critical issues associated with fabrication of the detector would be addressed and fabrication approaches would be demonstrated. Coupling of the detector to appropriate readout structures would also be accomplished.

POTENTIAL COMMERCIAL MARKET: Sensitive laser radar detectors at eye-safe wavelengths would greatly increase the potential applications of laser radar systems. Imaging in factories for process control, imaging for nondestructive testing, and imaging for surveillance and security are examples where this technology can be applied.

REFERENCES:
1. R.D. Richmond and R. Stettner, "Laser radar focal plan array for three-dimensional testing," Proc. SPIE Vol. 2748 (Apr 96).
2. J. A. Overbeck, M.S. Salisbury, M.B. Mark, and E.A. Watson, "Required energy for a laser radar system incorporating a fiber amplifier or an avalanche photodiode," Appl. Opt. 34(33), 7724-7730 (1995).

END OF TOPIC

POINT OF CONTACT: Gary Smith, (513) 255-9408, smithg@el.wpafb.af

AF97-127 TITLE: <u>Architecture and Components for Modular, Multifunction Electro-Optical (EO) Avionic Systems</u>

OBJECTIVE: Develop and define compact and affordable integrated multifunction open architecture EO systems.

DESCRIPTION: The ultimate desired EO system would perform a variety of mission-critical functions, including target detection and recognition, precision weapon delivery, covert communication with friendly aircraft, missile and laser warning, and countermeasures against IR and EO threats. The successful integration of multiple EO functions into a compact, low cost system will revolutionize battlefield awareness and precision engagement. Architectures and critical component technologies leading to this ultimate sensor are of interest in this effort. Areas of interest include:

a) Conformal optical apertures that will rapidly, agilely, and precisely steer, with no gimbals, both the incoming image information and outgoing laser radiation. A broad spectral range as well as a large steering angle capability is required for both the image and laser radiation.

b) Multifunction laser sources capable of target designation, of imaging at eye-safe wavelengths for target recognition, of covert optical communications, and of infrared countermeasures. These sources may be required to be sepctrally agile and coherent to increase the number of dimensions used in the target recognition space.

c) Sensitive infrared and laser receivers for target imaging and threat detection with high resolution and with multiple wavelengths.

d) Optical "backbone" for distribution of laser energy and connection/integration of optical apertures with common central processing.

PHASE I: Design and assessment of system architectures and critical components. Multifunction EO components will be designed, and detailed cost and risk assessments will be made. Methods of component integration will be defined.

PHASE II: Fabricate and quantitatively evaluate multifunction components at brassboard level. Develop detailed plan for integrated product in Phase III.

POTENTIAL COMMERCIAL MARKET: The multifunction technologies developed will have broad application to more conventional federated systems in military, medical and commercial arenas. The optical aperture technologies will find application in all surveillance sensors such as for facility security as well as

for machine vision in robotics. The source and receiver technology will be directly applicable to remote sensing for pollution monitoring. Optical interconnection and distribution technologies development will support all manner of products in the fiber-optic communication industry, including phone line interconnects and chip-to-chip communications in computers.

REFERENCES:
1. P.F. McManamom, T.A. Dorschner, D.L. Corkum, L.J. Friedman, D.S. Hobbs, M. Holz, S. Liberman, H.Q. Nguyen, D. P. Resler, R.C. Sharp, and E.A. Watson, "Optical Phased Array Technology," Proc. IEEE Vol. 84(2), 268-298 (1996).

END OF TOPIC

POINT OF CONTACT: Ed Watson, (513) 255-5285, watsonea@aa.wpafb.a

AF97-128 TITLE: Robut Multi-Function Laser Sources

OBJECTIVE: Develop robust, multi-function laser sources which are insensitive to environmental changes.

DESCRIPTION: A robust, multifunction, compact laser source is needed for airborne applications where extremes in temperature, pressure, and vibration are present. Thus the laser source must be rugged and reliable with minimal maintenance. In particular, device performance in terms of beam quality and operating efficiency must be either insensitive to optical alignment or automatically aligned. A device with few or no moving parts is also highly desirable since every part in a laser device adds to its complexity and the possibility that malfunctions will occur. Maintaining high quality optical coatings over long periods of time under adverse operating conditions is also a reliability problem for laser sources; innovations which could make optics repeatedly exhibit greater than 10,000 hours between failure is needed. Finally, while the number of airborne applications for lasers increases, the available volume and power on an aircraft do not. A different laser for each application is not going to be viable. A laser source which is flexible in terms of repetition rate (10 Hz to 10 kHz), output pulse energy (joules to millijoules) and wavelength (1-12 microns) is needed to meet diverse needs in the areas of target designation, obstacle avoidance, laser radar, and infrared countermeasures. A multifunction laser source must also operate reliably under the environmental extremes experienced aboard a jet fighter aircraft.

PHASE I: Demonstrate the feasibility of an innovative technique, concept, or device which would lead to a major improvement in reliability, reduced maintenance, or multifunctionality.

PHASE II: Demonstrate a complete device suitable for flight testing which incorporates the innovation demonstrated in Phase I. Device performance will be tested under a full suite of environmental extremes including lifetime, failure modes, and multifunctionality.

POTENTIAL COMMERCIAL MARKET: A reliable, rugged, low maintenance, simple-to-operate laser source is needed for many commercial applications as well as military ones. A number of important commercial applications, especially environmental monitoring, are basically not being pursued because the available laser sources are too complex and expensive to operate. Other commercial applications, currently not even contemplated, would also appear once a simple and reliable laser source was available.

REFERENCES:
1. OSA Proceedings on Advanced Solid-State Lasers, Bruce H.T.

Chai and Stephen A. Payne, eds. (Optical Society of American, Washington DC 1995) Vol. 24.

END OF TOPIC

POINT OF CONTACT: Dr. Ken Schepler, (513) 255-3904, scheplkl@aa.

AF97-129 TITLE: Nonlinear Optical Frequency Conversion of Ultrafast Sources

OBJECTIVE: Develop schemes for efficient nonlinear frequency conversion of ultrafast solid-state, fiber, and diode lasers.

DESCRIPTION: Ultrafast laser sources are enjoying a period of significant development and application. This work has been spurred by the emergence of practical ultrafast laser designs based on solid-state, fiber, and diode lasers. The short pulse characteristics of these lasers make them important tools for spectroscopic, remote sensing, and scientific uses. The high intensity of short pulses make them particularly useful in situations where high peak power is required. Thus in nonlinear frequency conversion, efficient interactions are obtainable with the high peak powers that are generated in ultrafast lasers. This topic will develop efficient nonlinear frequency conversion techniques using ultrafast laser pump sources while mitigating temporal dispersion effects. Applications for ultrafast sources can be found in all regions of the UV, visible, and IR spectrum. The use of conventional birefringently phasematched materials is acceptable, but the new quasi-phasematched materials are of particular interest because of their capability to tailor the spectral properties of the phasematching.

PHASE I: Demonstrate a concept for nonlinear frequency conversion of an ultrafast solid-state, fiber, or diode laser, and establish the feasibility of the design and its potential utility.

PHASE II: Build a prototype system and demonstrate its applicability.

POTENTIAL COMMERCIAL MARKET: The commercial applications of this technology include environmental sensing systems for industrial process monitoring and pollution control. For example, the sensing of hydrocarbons is important in these applications, and it is a constituent of vehicle exhaust that may be used as a detectable signature by a multispectral sensor. Spectrophotometers and spectro-ellipsometers are optical instruments used in the characterization of material reflection/absorption and in measuring thin film thickness and refractive index. Coherent versions of these devices will be important for high accuracy measurements. The same spectral activity that makes the multispectral sensor of such interest ot the Air Force also makes these devices of great utility in spectroscopic applications. The monitoring of film deposition during semiconductor processing is a promising commercial application of a spectroscopic system using this technology.

REFERENCES:

1. "Advanced Solid-State Lasers," 1996 Technical Digest,

Optical Society of American, Washington DC (1996).

END OF TOPIC

POINT OF CONTACT: Larry Myers, (513) 255-3804, myersle@aa.wpafb.

AF97-130 TITLE: Coherent Spectroscopic Instrumentation

OBJECTIVE: Develop coherent spectroscopic instruments such as spectrophotometers, spectroellipsometers, and environmental monitors.

DESCRIPTION: Present nonlaser based spectroscopic instruments have low brightness light sources (low power per unit spectral bandwidth) which limit measurement sensitivity and provide poor absolute accuracy. High brightness laser sources would provide better signal-to-noise ratio and hence allow for more accurate measurements. However, lasers generally operate at fixed wavelengths or have limited tuning over the technologically important spectral regions. Nonlinear frequency conversion, for example, optical parametric oscillators and difference/sum-frequency generators can produce a high brightness source with wide tunability. The objective of this project is to develop a coherent spectroscopic instrument which uses nonlinear frequency conversion to generate tunable wavelengths. The emphasis is the development of compact, practical sources suitable for scientific instrumentation or environmental sensing over distances typical of industrial facilities. Measurements of interest include transmission/reflection of low loss coatings and mirrors, accurate absorption and dispersion values for optical materials, precise thickness and index of films deposited or grown on substrates, and remote detection of environmentally sensitive gases in industrial processes and hazardous chemicals in military situations. Nonlinear frequency conversion using the new materials for quasi-phasematching may result in particularly efficient and widely tunable designs.

PHASE I: Develop a concept for a coherent spectroscopic instrument and demonstrate key technical aspects to establish its feasibility.

PHASE II: Build a prototype system of the coherent spectroscopic instrument and demonstrate its measurement capability.

POTENTIAL COMMERCIAL MARKET: The Air Force applications of this technology are primarily in new sensor systems. For example, innovative methods of propagation through the atmosphere have been demonstrated with ultrafast lasers, and nonlinear frequency conversion of these sources can be used to shift the wavelengths to that required for Air Force missions (e.g. >1.5 um for eye-safe operation, or 3-5 um for penetration of haze). Another example is the use of an ultrafast laser combined with a nonlinear frequency converter in the sensor receiver for efficient upconversion of the return signal.

Commercial application of this technology lies in making ultrafast laser sources available at wavelengths where direct laser devices do not operate well. This will broaden the

market potential for the newly emerging ultrafast lasers.

REFERENCES:

1. "Advanced Solid-State Lasers," 1996 Technical Digest, Optical Society of America, Washington DC (1996).

END OF TOPIC

POINT OF CONTACT: Larry Myers, (513) 255-3804, myersle@aa.wpafb.

AF97-131 TITLE: <u>Digital Multifunction Sensor</u>

OBJECTIVE: Develop and design a digital multifunction sensor system for advanced airborne platform.

DESCRIPTION: Avionics sensor systems are on the verge of revolutionary advancements, due to, advancements in apertures, miniature filters, direct digital synthesis, analog/digital converters, amplifiers, and mixers. These advances are due to materials, packaging, interconnect, sealing, chip compaction and process control improvements due in large part to transmit/receive module development and commercial processor chip developments. This program will explore applications of new technologies based on sensor requirements and constraints to meet our far-term vision of multifunction digital RF sensors. Enabling Sciences have advanced from Material, Engineering and Mathematical sciences such as Statistics (Estimation Theory), Numerical Techniques (Adaptive Processing), and Communication Theory (IF Sampling). Thus, the combination of enabling science and technology gives hope/confidence that an all digital multi-function RF sensor suite will be accomplished and that this effort allow us to begin to understand the research required and technology needs associated with this vision.

1. Conformal Multifunction Array: Airborne antenna apertures of the future must be low cost, broad band, low radar cross section (RCS) and multifunction in nature to earn their way onto platforms where space is at a premium. To achieve these requirements, radically new aperture technologies need to be cultivated. This research explores a) pattern control for an aperture that is conformal to a doubly curved surface which has never been done before. Electromagnetic computational codes will be developed to rigorously predict the phenomena associated with scanning a beam on a generally doubly curved aperture, and b) the potential for generating multiple simultaneous beams on a general double curved surface which has never been done before. Electromagnetic computational codes will be developed to predict the phenomena associated with formation of multiple beams on a doubly curved surface.

2. System and Concept of Operation: 1) strategies for developing those technologies required to achieve an all digital multifunction RF system, 2) system and concept of operation studies to determine the benefits of potential off-board cues or bi-static operations, and 3) the benefit of multifunction waveforms to timeline loading and survivability through simulation analysis. These studies and analyses will attempt to balance the cost of ownership (i.e., acquisition, operating, and support costs), installation, and performance constraints.

3. Wideband Digital Antenna Electronics: Current antenna electronics at present assumes conventional Nyquist A/D technology. RF (at the microwave band of interest) is converted to IF and finally to baseband. This research explores the emerging Delta-Sigma A/D technology which presents an opportunity to modify the architecture to incorporate a set of dynamically tunable A/Ds that hop, digitize and filter signals at RF. This sampling technology could allow for the reduction of size, weight and cost of a sensor while increasing sensor performance and flexibility.

4. Advanced Spread Spectrum Filter Technology: Current sensor approach to acquire long pseudo-random sequences uses many parallel correlators to simultaneously search multiple Doppler windows. This research will determine the feasibility of using a new innovative signal processing approach which integrates the best frequency and time domain processing algorithm technology with monolithic microwave integrated circuit technology to implement a very cost effective matched filter.

PHASE I: Research and define a digital multifunction system or Subsystem including applicable technology trades, performance and cost trades.

PHASE II: Define systems interfaces for platform applications and build and test a critical sub-system.

POTENTIAL COMMERCIAL MARKET: Resulting technology applicable to automobiles or commercial aircraft for low-cost antenna, high performance antenna, or ultra-low noise communication system.

REFERENCES:
1. M.J. Povinelli, A Planar Broad-Band Flared Microstrip Slot Antenna, IEEE Trans. on Antennas and Propagation, Vol. AP-35, No. 8 Aug 1987, pp. 968-972.
2. K.M. Pasala, E.M. Friel, Mutual Coupling Effects and Their Reduction in Wideband Direction of Arrival Estimation, IEEE Trans. on Aerospace and Electronic Systems, Vol. 30, No.4, Oct 1994, pp. 1116-1121.

END OF TOPIC

POINT OF CONTACT: Todd Kastle, (513) 255-3006, kastleta@aa.wpafb

AF97-132 TITLE: Digital Frequency Modulation

OBJECTIVE: Develop digital frequency modulation capabilities for advanced active electronic attack (EA) techniques.

DESCRIPTION: Advanced coherent EA exciters require frequency modulation capability to effectively defeat certain threat radars. Current analog modulation schemes are counter productive to the digital advances being made in coherent exciters. Digital radio frequency memories (DRFM) have significantly enhanced the time domain performance of coherent EA subsystems. However, many modern threat systems are able to reject deception signals which only produce time domain perturbations. A critical need exists in these systems to provide coordinated time and frequency domain techniques. Having the capability to produce frequency modulations on the signal while in digital form has the potential to significantly reduce size, weight, cost, and power as well as enhance the time-frequency coordination of EA systems. Digital frequency modulation will also afford advanced coherent EA subsystems the capability for spectral content deception techniques that provide platform type "signatures." Limited past research has produced various digitally fed analog implementations where the digital modulation signal is converted to analog prior to mixing with the desired signal. The objective of this effort is to design, develop, and analyze a frequency modulation algorithm entirely with digital hardware.

PHASE I: Design a novel, advanced digital frequency modulation subsystem based on current Wright Laboratory performance requirements for EA applications. The design must be based on amplitued sampled digital words and impose the shift by digital manipulation. Consideration must be given to minimize the impact to data throughput time.

PHASE II: Develop prototype hardware and evaluate the proposed design in context of coherent digital EA systems for ability to provide coordinated time/frequency modulations and spectral content deception.

POTENTIAL COMMERCIAL MARKET: The developed digital frequency modulation has potential use in a variety of commercial applications such as digital communications, data packet coding, cellular telephones, cable and standard data modems, intelligent highways, and signal instrumentation.

REFERENCES:

1. A Digital Single-Sideband Modulator for A Digital Radio Frequency Memory, AFIT Thesis, Capt Thomas M. Foltz, USAF, Dec 1988.
2. Signature Development For A Digital Radio Frequency Memory Jammer Signal, AFIT Thesis, Capt Vicki M. Sundberg, USAF, Dec 1990.

References can be obtained by calling Marvin Potts at (513)255-4322.

END OF TOPIC

POINT OF CONTACT: Marvin Potts, (513) 255-4322, pottsmn@aa.wpafb

AF97-133 TITLE: Combinted Ultrawideband Radar/Communications Avionics

OBJECTIVE: Develop an ultrawideband transceiver capable of performing short range radar and communication functions.

DESCRIPTION: Current avionics systems have been developed to provide only a single function. The large number of functions required from today's avionics and the shortage of payload volume and load carrying capability, especially in unmanned air vehicles (UAVs), necessitate the combining of functions and sharing of resources. Some missions, such as those of Special Operations Forces, require low-probability-of-intercept (LPI) radar and communications for formation flying and rendezvous. Hence, there is a need for a single avionics package that can perform radar ranging to a distance of 15 to 20 nautical miles (nm) and can transmit and receive digital communications at a maximum range of 100 nm with a data rate of 16 kilobits/second using featureless waveform technology. Such a system can be used for rendezvousing and communicating with refueling aircraft and other aircraft within a formation. It can also be used for navigation and radar altimetry by fixed and rotary wing aircraft, and for station keeping and control of UAVs. Use of spread spectrum, featureless waveform for both radar and communications will greatly enhance the survivability of the using vehicle.

PHASE I: Investigate various means of generating and receiving an LPI waveform that can be used for both radar and communications functions. Investigate beam steering methods that can be used for radar and communications. Develop a functional architecture for such a system. Determine military and commercial applications.

PHASE II: Design, fabricate and test a system in accordance with the Phase I functional architecture. Determine the suitability of using such a system on helicopters, light aircraft and UAVs.

POTENTIAL COMMERCIAL MARKET: This system has potential uses in commercial and general aviation for ground proximity warning, collision avoidance, and communication functions.

REFERENCES:
1. G.E. Prescott, D. Connolly, L. Gutman, "A Modulation Quality Factor for Low Probability of Intercept (LPI) Communication Systems," AGARD, Avionics Panel Symposium, Fall 90, Munich, Germany, 1-4 Oct 90.

Reference available by calling Dave Pleva at (513) 255-5565.

END OF TOPIC

POINT OF CONTACT: Dave Pleva, (513) 255-5285, plevadw@aa.wpafb.a

AF97-134 TITLE: Chaff Dispenser Location Computer Model

OBJECTIVE: Develop a model to determine the optimum aircraft location for chaff/expendables dispensers.

DESCRIPTION: Create a computer based model for Air Force and Navy application to assist in determining the optimum location for chaff/expendable dispensers. This program would model the 6 degree-of-freedom characteristics of the air flow across aircraft surfaces, vortices, jet engine exhaust, rotor or blade effects, winds, chaff pyrotechnics, type of chaff and dispenser location and position. With detailed models of the aircraft, the program will allow relocation of the dispenser or dispensers to any location on the aircraft. This effort will also assist in creating a chaff database to represent chaff RCS and Doppler for specific types of chaff. This program would be written such that it will run on a PC or workstation and will be incorporated into the existing MARCS (Missile, Aircraft, Radar, Countermeasures Simulation) electronic countermeasures simulation.

The utility of this type of computer program is to allow the user to run the program either as a stand-alone program or within the computer simulation MARCS to evaluate countermeasures effectiveness. The program would be available to the Tri-Service community, aircraft manufacturers and integration engineers for chaff dispensers, foreign countries and NATO.

Contractor performing work would have to be familiar with chaff/expendables, chaff/expendables dispensers, computer model generation and programming, and modifying the source code of MARCS (including the modeling chaff in MARCS data files).

PHASE I: Determine the initial feasibility of the concept through design, physical analysis, computer based modeling and analysis.

PHASE II: Develop validated computer model, explore critical parameters and design means of implementation.

POTENTIAL COMMERCIAL MARKET: There is potential commercial application of these models to aircraft such as Air Force One and for DOD contractors working on aircraft such as the F-22.

REFERENCES:
1. NAVAIR-16-1-539, "NAVAIR Expendable CM Directory."

END OF TOPIC

POINT OF CONTACT: Garry Grider, (513) 255-5976, gridergm@aa.wpaf

AF97-135 TITLE: Global Positioning System (GPS) P(Y)-Code Acquisition

OBJECTIVE: Develop and evaluate innovative techniques that utilize RF/EO technologies for GPS Direct P(Y)-Code acquisition.

DESCRIPTION: GPS acquisition is currently accomplished using Coarse/Acquisition (C/A) Code. C/A Code is 1 MHz Gold Code sequence that repeats every 1 msec. These properties make the C/A-Code easily acquired with relatively simple hardware. However, these same code properties make acquisition using C/A-Code vulnerable to jamming and spoofing. Acquisition of GPS using 10 MHz P(Y)-Code pseudo-random (PN) sequence greatly improves system acquisition jamming and spoofing immunity but makes acquisition of the code much more difficult. The difficulty stems from the fact that the jamming requires a large number of chips be integrated for each correlation. The P(Y)-Code chipping rate requires that a large number of correlations must be performed to search even small time uncertainties. Also large Doppler windows have to be searched for frequency uncertainty due to oscillator and doppler uncertainties. These factors create a two dimensional (time and frequency) area that must be searched to acquire the P(Y)-Code. The problem is further compounded by operational considerations which require this search be accomplished with affordable low power/small hardware, in a short period of time, and in a jammed environment. The current Direct P(Y)-Code acquisition approach uses a large number of parallel correlators and/or precise clocks. These approaches can achieve reasonable time-to-first-fix (TTFF) (several minutes) when searching time uncertainties on the order of 50 msec and frequency uncertainties of several hundred hertz for J/S ranging from 35-40 dB.

PHASE I: Investigate/develop RF/EO technologies and search techniques that have the potential to greatly improve the speed at which large time and frequency uncertainties can be searched. The acquisition time goal for this effort is less than 15 minutes for time uncertainty of 2 seconds, frequency uncertainty of +/- 300Hz and J/S of 43 dB. The approach and technologies chosen must have cost, size, and power consistent with the constraints of most GPS applications.

PHASE II: Optimize the design of the acquisition technique developed under Phase I and characterize the techniques performance using analysis, simulation and hardware demonstration.

POTENTIAL COMMERCIAL MARKET: This technique can provide commercial GPS receivers with a C/A code rapid acquisition capability. This technique can also be exploited by any real time signal processing application performing signal correlations such as spectrum analyzers, image/speech

processing or coded telecommunications.

REFERENCES:
1. O. Brazzi, R. Torguet, C. Bruneel and J.C. Kastelik, "A Compact acousto-optic correlator for rapid GPS signal processing," IEEE Ultrasonics Symposium, Maryland, 1993.
2. O. Brazzi, R. Torguet, C. Bruneel, M. Gazalet and J. Rouvaen, "Space-integrating acousto-optic processor for rapid Global Positioning System signal acquisition," Optical Engineering, September 1994, Vol. 33 No. 9, pp. 2931-2935.

END OF TOPIC

POINT OF CONTACT: Capt Anthony Romano, (513) 255-4742, romanoa@a

AF97-136 TITLE: Avionics Modeling and Simulation Technology

OBJECTIVE: Develop realtime and non-realtime simulation technology for collaborative engineering and virtual prototyping of avionics systems.

DESCRIPTION: The contractor will develop simulation technologies to enhance DoD productivity and commercial sector competitiveness by advancing real-time and non-real-time desktop collaborative virtual prototyping processes and applications. Proposals should build on the significant technology base existing for electronic systems design (VHDL, AHDL), Joint modeling and simulation (M&S) standards, and other commercial/industry modeling standards. Collaborative Virtual Prototyping (CVP) involves the application of advanced distributed modeling and simulation over a geographically disperse area using an integrated simulation environment to support design, performance, and producibility trade-off analyses throughout the entire life cycle of system development. The high-leverage Joint standards and M&S initiatives include the DoD High Level Architecture, Joint Simulation System (JSIMS), the Joint Warfare Simulation (JWARS) and the Joint Modeling and Simulation System (J-MASS). Using CVP, a simulation model, developed in parallel with the hardware or technology development, allows the scientist, engineer, or end user to refine system requirements early in the engineering process. A virtual prototype allows the engineer on the desktop to see the impact of design changes. Trade studies using the model can then be performed throughout development as an essential part of the systems engineering process. The Joint M&S Standards emphasize models based on reusable components. The virtual prototyping tools necessitate research in areas such as simulation engineering based on visual programming and visual assembly with domain specific icons and browsers, automated test, automated verification and validation, model based software requirements development, parallel automated documentation, automatic code generation with multiple language support, embedded configuration control, multimedia help and on-line documentation, domain specific toolkits for component developers to populate libraries, application developer toolkits to define requirements and compose model software from components, expert system assistants and domain specific software structural models.

PHASE I: The desired products of Phase I are 1) identification and development of applicable desktop M&S processes and requirements for avionics, 2) identification of the enabling realtime or non-realtime technologies for avionics M&S based upon employing J-MASS as the underlying modeling system, and 3) conduct of specific experiments to verify critical aspects of the defined concepts, 4) development of a system specification, implementation approach, and

demonstration plan.

PHASE II: Design and develop the prototype technology and demonstrate the proposed technology in the appropriate Wright Laboratory System Concept and Simulation Division simulation facility. The contractor shall also detail his plan for his Phase III effort.

POTENTIAL COMMERCIAL MARKET: M&S is an enabling technology and a change in the way of doing business that will have major implications for the commercial and defense sector. Desktop M&S will become a mainstream concept in the design and production of commercial systems. The commercial marketplace will increase for generic simulation techniques, simulation infrastructure, and off-the-shelf components for applications in financial industries, manufacturing, industrial process control, biotechnology, health care, communication and information systems. Boeing demonstrated the success of integrated computer assisted design with supporting modeling and simulation in bringing to market the 777 airliner. Similarly, the automotive industry has used CAD and modeling for years. Advances in software and computer technology is making CVP and desktop M&S possible and affordable for the small to medium business. Software development itself is a manpower intensive endeavor. Requirements definition remains a problem area where the user is unable to verbalize what he/she wants in detail. Virtual prototyping of software requirements and modeling of the software is a future growth area in which simulation is used to review completeness of software requirements and functionality.

REFERENCES:
1. "J-MASS and Concurrent Simulation in the Laboratory Environment," NAECON Conference Paper, February 1996, Public Release Case Number ASC 96-0138.
2. "Avionics Wind Tunnel, Laboratory Interface Development," NAECON Paper, May 1993.

These references plus additional references are available at the WL/AASE Technical Information Center, contact William McQuay at (513) 255-4511 for additional information.

END OF TOPIC

POINT OF CONTACT: William McQuay, (513) 255-5285, mcquaywk@aa.wp

AF97-137 TITLE: Electronic Design Automation

OBJECTIVE: Develop electronic design automation tools and methods which support the design of complex analog and digital electronic systems.

DESCRIPTION: The Air Force continuously develops complex electronic components and systems for its weapons. Significant cost savings can be achieved if design times and design errors are reduced and the appropriate factors are considered during the initial design of this equipment. Electronic Design Automation (EDA) or Computer Aided Engineering (CAE) technologies play a key role in achieving a successful weapon system design while reducing its cost. The AF's primary interests are tools that a) allow technology independent, parameterized, automated generation of analog building blocks (i.e., op-amps, filters A/D converters etc.) b) allow high level synthesis of analog circuits from VHDL-A (the emerging IEEE standard), c) support the design of low power electronics (e.g., asynchronous logic or multivalued logic) d) dramatically reduce system design and verification time, e) help a design team view and manage complex designs, or f) that help a designer work with commercial-off-the-shelf parts. Inputs to a tool should be either an industry standard format such as VHDL or VHDL-A, libraries of design choices, or some other natural format that is intuitive to the design team member that is targeted to use this tool. Outputs should be compatible with other tools that are used in follow-on stages of the design process. The tool must have interfaces to the CAE or enterprise framework and data bases on which it is intended to operate. Duplication of capabilities that are already commercially available or that are already receiving significant investment by the DOD are strongly discouraged.

PHASE I: The preliminary design of the tool will be performed. The functionality, user interface, and design environment interface will be completely specified.

PHASE II: The tool will be constructed, evaluated, and demonstrated. Reference manuals and user guides will be developed.

POTENTIAL COMMERCIAL MARKET: All tools developed under this topic will be inherently dual-use. This is because the same methods used to design military electronic systems are applicable to commercial systems, although military systems design often includes additional requirements such as legacy system support and adverse operational environment support.

REFERENCES:
1. Antao and Broadersen, "ARCHGEN: Automated Synthesis of Analog Systems," IEEE Transactions on VLSI Systems, VOL. 3 No. 2, June 1995, pp. 231-244.

2. ANSI/IEEE 1076 VHSIC HARDWARE DESCRIPTION LANGUAGE (VHDL) REFERENCE MANUAL

END OF TOPIC

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AF97-138 TITLE: Single-Mode Reliable Optical Card-Edge Connector

OBJECTIVE: Develop, design and test a reliable, rugged, blind-mate single-mode optical connector for avionics modules.

DESCRIPTION: For decades research has been performed on solving the problems associated with optical connectors for avionics applications. Efficient and reliable bulkhead connectors have been in use for several years. However, blind-mate connectors for avionics line replaceable modules (LRM) need to be developed to reduce problems associated with fiber optics and photonics. The connector problems include the inability to maintain optical alignment, excessive damage under shock and vibration, contamination of exposed fiber ends, and degradation of the alignment sleeves and fiber surfaces. Other concerns result from transitioning from light emitting diodes (LED) to laser transmitters such as eye safety. To help alleviate these reliability and maintainability problems with optical networks in weapon systems such as the Air Force F-22 tactical fighter, a reliable, blind-mate optical connector using multimode fiber has been developed. A prototype was built, tested and transitioned to the F-22 program. This connector is fine for most digital applications. The next technology step is to develop a single-mode reliable optical connector. There are many benefits of developing this connector so that it can be used in optical systems with laser transceivers. Higher power margins can be achieved. Greater bandwidths than that of LED systems will be attained.

PHASE I: Will involve 1)establishing a preliminary connector design (either a new design or enhanced existing design), 2) providing a mock-up of this innovative design, and 3) creating a development plan for the chosen concept.

PHASE II: Will involve the detailed design, prototype development, and testing of this single-mode optical connector. This will include any demonstration applicable to a commercial application of this technology concept. The testing will include the rigors of the severe military environment and maintenance procedures to which the avionics and connector will be subjected.

POTENTIAL COMMERCIAL MARKET: Commercial avionics have become more sophisticated and faster, using laser transmitters. This connector can be used for sensor to processor data transfer and airline seat monitor and entertainment bus connections. Ground-based super computers with optical networks will require these for connecting peripherals, central processors, and monitors. Commercial space applications such as satellite and medical payloads require rugged connectors that operate in a harsh environment.

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END OF TOPIC

POINT OF CONTACT: Steve Benning, (513) 255-4709, benninsl@aa.wpa

AF97-139 TITLE: Missile Warning System Scene Projection

OBJECTIVE: Develop an EO scene projection technology for missile warning system evaluation.

DESCRIPTION: The development and evaluation of missile warning system technology/enhancements have required extensive flight tests. Recent breakthroughs in digital IR scene generation capability developed for the Wright Laboratory Integrated Defensive Avionics Laboratory (IDAL) was transitioned to WR-ALC to provide a capability to perform hardware-in-the-loop simulations for developing algorithm/software enhancements for the AAR-44 missile warning system. This capability allows the development and evaluation of these enhancements prior to flight test. This capability significantly reduces the required flight tests and significantly increases WR-ALC's ability to respond to the warfighter's evolving missile threats. The current capability provides a digital scene that is injected into the missile warning system processor. Current EO scene projection technology is expensive and does not provide the required capability converting digital scenes to optically projected scenes that could be used to stimulate the missile warning system's sensor optics. This requires innovative research to define/develop EO scene projection technology that can interface to digital scene generators and provide an optical scene to stimulate missile warning receivers such as the AAR-44, AAR-47 and the joint service Common Missile Warning System (CMWS). This scene projection technology would be demonstrated and utilized in the IDAL for the development of missile warning system technology.

PHASE I: Define the key technical requirements/issues, develop a preliminary concept/design and provide an implementation approach including feasibility and cost tradeoff analysis. Performance demonstrations of critical aspects of the design are desired to evaluate risk in proceeding with Phase II.

PHASE II: Develop, fabricate, demonstrate and document proposed concept/design. Based on the Phase II results, provide recommendations on how the resulting technology can be applied to fulfilling commercial needs.

POTENTIAL COMMERCIAL MARKET: This SBIR topic has dual use potential for the laboratory development of IR camera technology. The conversion process for transforming digital scene information into optically transmitted scene information has potential application to the television industry for quick response flat screen technology. The projection technology also has application to the commercial airlines industry for crew training using projection technology to stimulate the forward-looking infrared (FLIR) autonomous landing system being developed for category III landings (minimum ceiling visibility

of 50 feet).

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These references and additional references are available from the WL/AASE Technical Information Center. For additional information, contact Roderic Perry at (513) 255-4264.

END OF TOPIC

POINT OF CONTACT: Roderic Perry, (513) 255-4264, perryrc@aa.wpaf

AF97-140 TITLE: <u>Innovative Electron Beam (EB) Cured Structures</u>

OBJECTIVE: Develop a new class of low cost, highly efficient composite structures enabled by EB cure.

DESCRIPTION: The Air Force seeks to exploit the unique processing and tooling allowed by EB cured composite materials to develop new, low cost, highly efficient aircraft structural concepts. EB cure combined with advanced fiber reinforcement textile products and low cost processing techniques such as resin transfer molding (RTM), vacuum-assisted resin transfer molding (VARTM), and fiber placement shall be employed. Highly efficient structural concepts that are unproducible and/or unaffordable with two-dimensional lay-up and thermal autoclave cure materials shall be developed. Low cost tools made of wood, cardboard, plaster, and/or plastics shall be employed to fabricate the concepts. Highly unitized structural concepts with low part and fastener count featuring efficient load transfer through joints and intersections such as integral sin and substructure shall be developed. Highly efficient substructure concepts such as truss and geodesic webs shall be considered.

PHASE I: Small subcomponents shall be built to demonstrate the feasibility of the fabrication process and evaluated to provide the initial demonstration of structural efficiency.

PHASE II: Full size structural components shall be designed, fabricated, and tested to demonstrate the structural design concept and validate the manufacturing and tooling approach.

POTENTIAL COMMERCIAL MARKET: Low cost EB cure composites will create new multi-million dollar markets for high performance composite materials in cost driven commodity type products. The use of high performance composites is currently limited to premium cost products. EB cure composites could enable a significantly greater use of composites in commercial automobiles, trucks, buses, and trains leading to significant weight savings and improving fuel efficiency thereby reducing consumer energy costs. EB cure composites will enable application to an array of economical consumer products from lightweight appliances and bicycles to fishing poles and power tools. A great market potential also exists for application to lightweight, long life, corrosion free composite building components such as columns, beams, and girders for public bridges and buildings.

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END OF TOPIC

POINT OF CONTACT: Jim Tuss, (513) 255-5865, tussjm@b045mail.wpaf

AF97-141 TITLE: Distributed Actuation for Aircraft Maneuver and Performance Enhancement

OBJECTIVE: Develop innovative concepts in actuation, distributed throughout the structure, to achieve aircraft maneuver and performance enhancement.

DESCRIPTION: Innovative concepts are solicited in the use of smart/distributed actuation as applied to flight vehicle structures. The employment of such concepts can effect both the performance characteristics and the total weight of aircraft. The elimination of the need for conventional, discrete control surfaces can have major impact on flight vehicle weight, drag, and signature. Other distributed actuation concepts can be applied to structural problems such as buffet alleviation, flutter suppression, vibration isolation critical components, and anti-icing. (The results of a recent SBIR feasibility study in the area can be found in the reference.)

PHASE I: Perform a feasibility study (primarily analytical) of employing the selected concept to either a current operational vehicle or to a new vehicle design. Determine the payoff of using the concept in terms of vehicle performance or in solving light vehicle structural problems. Estimate the weight impact of the new concept versus conventional designs.

PHASE II: Perform ground or wind tunnel tests (or both) to validate the concept developed in Phase I.

POTENTIAL COMMERCIAL MARKET: Distributed actuation can be used to design lighter weight commercial aircraft. In addition, many of the concepts (distributed actuation for vibration suppression, for example) have nonmilitary, nonaerospace uses and can benefit from concept feasibility studies.

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END OF TOPIC

POINT OF CONTACT: Terry Harris, (513) 255-5236X250, harristm@b04

AF97-142 TITLE: Structural Integrity of Aging Aircraft

OBJECTIVE: Develop methodologies for determining, assessing, and predicting the effects of various forms of aging aircraft damage.

DESCRIPTION: A variety of critical service problems are currently plaguing our aging aircraft fleets and threatening them with grounding or shortened service lives because accurate methodologies for prediction and assessment do not exist today. These problems include but are not limited to corrosion fatigue, widespread fatigue damage (WFD), fretting fatigue, fretting corrosion, joint debonding, composite delamination, and composite impact damage. Research efforts should involve generating analytical methodologies, validating these methodologies through experimental testing, and integrating these methodologies with existing aging aircraft computer codes. These models shall be suitable for integration into PC or workstation based deterministic fatigue crack growth, probabilistic risk assessment, and/or repair design and analysis computer programs. Emphasis areas are (1) fretting fatigue and fretting corrosion including testing techniques for validation (e.g. correlation of fretting corrosion and fatigue data produced in laboratory environment with data from aging aircraft by developing the appropriate transformation functions), (2) deterministic fatigue crack growth analysis model (e.g. in the plastic zone), (3) advanced life extension techniques (e.g. laser shock processing, ion implantation), (4) advanced analysis methodologies of composite repairs on metallic structures, (5) low velocity impact damage of bonded composite repairs on metallic structures, and (6) concept of equivalent initial flaw size.

PHASE I: Develop computer code modules suitable for integration with existing deterministic, probalilistic, and/or repair analysis computer programs as well as advanced life extension techniques.

PHASE II: Methodologies and techniques developed in Phase I will be validated by experimentation.

POTENTIAL COMMERCIAL MARKET: The methodologies and techniques are directly applicable to aging commercial aircraft as well as to new commercial aircraft. Also, the potential for use is extremely high in the automotive, shipping, railroad, nuclear and space industries.

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END OF TOPIC

POINT OF CONTACT: Michael L. Zeigler, (513) 255-5664, zeigleml@B

AF97-143 TITLE: Flight Control Technology

OBJECTIVE: Develop affordable flight control technology to support Air Force Global Reach, Global Power objectives.

DESCRIPTION: The Air Force is interested in the development of one or more of the following advanced flight control technologies for future air vehicles: a) computation based implicit air data systems, b) scalability of flight control test results between air vehicles lacking geometric similitude, c) closed-loop flight control of tactical aircraft with flexible structures, d)miniature actuators using smart materials for high response changes in wing shapes, e) virtual channel real-time fault tolerant computing architectures/techniques, f) multiple frequency optical multiplexing for fault tolerant flight control communication, g) domain based graphical software that automates and integrates redundancy management, mode logic, and interface programming with control law development, h) real-time optimization algorithms for engagement solutions for cooperative uninhabited air vehicles (UAV) and multiple target, i) optimization of UAV formation flight between aerodynamic benefits (reduction of induced drag) and sensing benefits (resolution of distributed aperture radar), j) development of an electronic, retrievable stability and control data base for various aircraft configurations based on both linear and nonlinear wind tunnel data, and k) development of flying qualities guidelines and criteria based on quantitative pilot workload assessment methods.

PHASE I: Expectations include determining the feasibility, preliminary concept identification and requirements definition. Some specific examples are photonic interface module design, control software interface design description.

PHASE II: Expectations include hardware fabrication, ground testing, simulation or flight testing, and validated, executable software code. Some specific examples include photonic interface fault tolerant communication elements built and lab tested, complete flight control software design tool built and demonstrated.

POTENTIAL COMMERCIAL MARKET: All of the items in this SBIR topic are generally applicable to both the civilian and military aircraft sectors. The technology developed will provide for greater integration at the system level, more affordable configurations, more efficient and supportable flight control architectures, and the ability to operate air vehicles safely and effectively in an internetted environment. All commercial aircraft manufacturers, suppliers, and airline would benefit from this technology.

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END OF TOPIC

POINT OF CONTACT: David Bowser, (513) 255-3110, bowserdk@WL.WPAF

AF97-144 TITLE: Tactical-Uninhabited Air Vehicle (T-UAV) Operator Station Simulator

OBJECTIVE: Develop, design, and demonstrate an operator station simulator for T-UAVs.

DESCRIPTION: Future DOD plans envision a T-UAV operator controllingmultiple vehicles. Operators require a simulation station to effectively train to control these platforms. Technology development personnel need a facility for research, testing, demonstration, and evolution. It is envision that a two-person station could control up to eight T-UAVs. A simulated operator station would provide operator trinees the means to monitor the vehicles' operation from both a strategic and tactical point of view. Such a station would also allow for control of the simulated vehicles through an interactive interface. The station would interact with other advanced flight management systems such as decision iaides and situation assessment systems. The aim of this program, then, is to research and design a T-UAV operator station simulator that allows for strategic and tactical displays and interactive control, considering human factors wngineering issues. An innovative approach is sought that takes into account advanced display hardqare technology, informtion display formats and controls, decision aides, and operator/vehicle interfaces.

PHASE I: Simulation station requirements definition to include an analysis of available advanced display technologies, mission definition and analysis, and T-UAV operationa requirements. Design an operator simulation station based on requirements analysis. Design should identify hardware and software requirements needed to implement prototype station and should include an interface control document. Limited prototype demomstation and evaluation of key design features.

PHASE II: Implement a prototype capability based on the design defined in Phase I. Demonstrate prototype operation ofr several T-UAV missions. Integrate prototype with established operator/vehicle interface technology deelopment facility.

POTENTIAL COMMERCIAL MARKET: The commercial potential of this work includes air traffic control, land surveys, drug interdiction, search and rescue, and, forest fire control.

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END OF TOPIC

POINT OF CONTACT: Capt Vincent K. Park, (513) 255-8252, parkvk@w

AF97-145 TITLE: <u>Full-Color Autosterographic True Three-Dimensional Displays</u>

OBJECTIVE: Develop an autosterographic true 3D display that is fully addressable, interactive, operator position independent, without special user equipment.

DESCRIPTION: Current technology portrays the world through the limitations of two-dimensional displays. These limitations restrict the perception of depth and viewing angles in complex scenes and object interactions. A true three-dimensional display will yield a more realisitic representation of the world that will simplify its understanding to a human observer. This will be especially useful t support control of multiple remotely operated air vehicles in complex, high workload environments. The objective of this effort is to develop the technology for a true three dimensional, full color autosterographic display system that produces images in true three dimensional space. This display will define a fully addressable, high resolution array of XYZ points in space for drawing solid surfaces, stick figures, and readable text. The display system will be high speed and capable of real time operation with a minimum of 60 3D frames per second. It must supply means for user interaction and a complete lookaround viewing capability. The design must include provisions for safety, considering a naked-eye operator/viewer, with no speacial equipment requirements.

PHASE I: Analyze and determine available technologies for an autosterographic full color, true three-diminsional display system and generate its design. Detemine display's maximum display volume, spatial resolution in XYZ space, refresh rate, number of colors, brightness, contrast, and graphics perfromance (e.g., 3D vectors, polygons). Define the display's specifications e.g., RGB input, RS-170A input) and requirements (e.g., input voltage), as well as its programming and user interfaces. Produce an analysis on how to integrate such design with WL/FIGP's laboratory facilities.

PHASE II: Design and build a working prototype 3D display system based on the results and conlusions of Phase I.

POTENTIAL COMMERCIAL MARKET: Three dimensional displays (3D) have wide applications in commercial ad military markets. Three dimensional displays have the potential of replacing current two- dimensional displays. Commercial applications include television, NMRI medical displays, air traffic control, remote vehicles operation, robotics, and remote telepresence operations.

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A number of references to holographic displays can be found by pointing your web tool to: http://www.altavista.digital.com and doing a simple search on "holographic displays." (Note the exact spelling.)

END OF TOPIC

POINT OF CONTACT: Antonio Ayala, (513) 255-8266, ayalaa@b045mail

AF97-146 TITLE: Global Diagnostic System for Unsteady Flow Fields

OBJECTIVE: Develop a nonintrusive flow diagnostic instrument capable of making off-body, global measurements of unsteady flowfields.

DESCRIPTION: Substantive advancements in both military and commercial flight vehicles hinge on understanding and exploiting unsteady flow phenomena. Wind tunnel tests require detailed quantitative measurements of flow variables (velocity, pressure, density, temperature) throughout the flow field to understand the flow phenomena and to validate computational fluid dynamics codes. Since probes inserted into the flow field may disturb the flow, these data must be taken by nonintrusive means. Furthermore, to allow detailed investigation of unsteady flow fields, these methods must allow simultaneous measurements on entire planes or volumes in the flow field. Some planar methods, such as Doppler Global Velocimetry (DGV) are capable of making global velocity measurements in the flow field. Others, such as Planar Laser Induced Fluorescence (PLIF) are capable of making density measurements. All these methods face limitations in unsteady flow fields because of the amount of data which must be acquired at high speeds. These methods also have limited dynamic range. A new method to augment these techniques or extend the dynamic range or accuracy typical of these techniques is desired. Ideally, this method would simultaneously provide information on multiple flow variables throughout the flow field. Furthermore, the dynamic range of an ideal technique would allow measurements of velocities ranging over at least 3 orders of magnitude in subsonic flows. This method must provide nonintrusive measurements and would most likely be optically based. The technique must be usable in wind tunnels with limited optical access. The technique should account for distortions due to nonoptical quality wind tunnel windows (e.g. plexiglass). Any seeding material used must be environmentally nonhazardous. The data acquisition hardware required to provide temporal resolution of unsteady flow fields for such a method may also need to be developed. This would require shutter speeds of less than 0.1 millisecond and frame rates of approximately 1kHz.

PHASE I: Phase I activity would identify a new diagnostic system or substantial advancements or improvements to existing techniques. The optical requirements, wind tunnel modifications, computer requirements and data reduction techniques applicable to this task would be identified and the feasibility of the technique wold be demonstrated.

PHASE II: Phase II would design and build the diagnostic system, including any specialized data acquisition hardware and data reduction software and install the system in the Subsonic

Aerodynamics Research Laboratory (SARL) wind tunnel in Wright Laboratory, or other facility, as suitable.

POTENTIAL COMMERCIAL MARKET: Significant advances in flow-field diagnostics have the potential of making a tremendous impact in the commercial aircraft, automotive and trucking industries. Improved fuel economy due to decreased vehicle drag might be achieved cost effectively by using enhanced diagnostic systems. Commercial wind tunnel tests may become simpler and less expensive while yielding orders of magnitude more data than are possible using existing testing techniques.

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END OF TOPIC

POINT OF CONTACT: Dr. Tom Beutner, (513) 255-2493, beutnetj@wl.w

AF97-147 TITLE: Cost Estimating Methodology for Advanced Air Vehicles

OBJECTIVE: Develop cost estimating model for advanced air vehicles.

DESCRIPTION: Affordability is a major factor in the development of advanced air vehicles technologies. The emphasis in developing affordable advanced air vehicles requires proper measurement of the impact of new technologies in the cost of developing advanced air vehicles. The Air Force Scientific Advisory Board new World Vistas Study "recommends that research efforts be established to define fundamental principles for cost determination and that all S&T projects consider the proper balance between life cycle cost and capability." Trade-off studies used to determine which new technology may give the best return on investment are limited due to the lack of existing cost estimating tools that do not address the impact of new technologies on air vehicle designs. Parametric cost estimating relationships (CERs) relying on historical, as-built data, cannot capture effects of advanced materials and technologies. Weight-based CERs only address existing materials mixes and do not take into account the functional complexity of a system, which in some cases drives the cost. Engineering build-up methods are labor intensive, manufacturer specific, and with a show turnaround. The development of a cost estimating tool that will address new technologies impacts in a more realistic manner is desired. Ideally, this development would take into consideration the favorable characteristics of parametric cost estimating relationships and engineering build-up methods, to provide a cost estimating tool that would yield a more reliable, realistic conceptual level life cycle cost estimate of the impact of new technologies in the development of advanced air vehicles. It is desirable that this tool would be developed to be used by design engineers and technical cost analysts.

PHASE I: Phase I would identify a new cost estimating tool and its feasibility, or major improvements to existing tools.

PHASE II: Phase II would develop and test the tool. This phase would include baseline testing for correlation purposes, as well as integration with existing conceptual/advanced design tools to provide a complete suite of tools that would be available to the design community.

POTENTIAL COMMERCIAL MARKET: Air Force, Navy, and industry have expressed interest in developing a cost estimating tool that would properly address advanced technology insertions and their impacts in conceptual and advanced air vehicle design. Affordability will dominate development, procurement, and operation of future weapon systems. Cost prediction is

essential to the determination of affordability. The commercial sector would benefit from the development of a cost estimating tool that would provide more realistic estimates of the impact of new and advanced technology insertion in future (post JAST) advanced air vehicle systems. This will result in development of affordable, high performance advanced air vehicle systems.

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4. Marks, K.E.; "An Appraisal of Models Used in Life Cycle Cost Estimation for USAF Aircraft Systems," Report R-2287-AF, Rand Corporation, October 1978.

END OF TOPIC

POINT OF CONTACT: Harold M. Vazquez, (513) 255-4294, vazquehm@wl

AF97-148 TITLE: Aeromechancis for Future Aircraft Technology Enhancement

OBJECTIVE: Develop aeromechanics technology to achieve affordable fighter aircraft with advanced maneuverability, extended range, and high survivability.

DESCRIPTION: The Air Force has a vital interest in the development of manned and unmanned aircraft with significant advancements in flight performance and mission effectiveness These advanced air vehicles will rely on innovation in aeromechanics technology to achieve new levels of speed, maneuverability, range, payload capability, low life cycle cost, and rapid design development. Advancements are needed in the following areas: a) accurate engineering design methods for determining aerodynamics characteristics and flight performance of unconventional aircraft, b) rapid efficient computational fluid dynamics methods to describe the airflow about air vehicles in rapidly maneuvering flight, c) flow control devices such as MEMS and active compliant surfaces which can be used to reduce drag or prevent flow separation, d) methods to improve the accuracy and reduce the cost of wind tunnel experiments through more accurate measurements and extrapolation of subscale results to flight, e) efficient integration of inlets and nozzles, and f) innovative aircraft configurations which produce advanced performance capabilities.

PHASE I: Define the proposed concept, outline the basic principles, establish the method of solution. Present an example of the advanced performance which will result from the technology. Determine the risk and extent of improvement over existing methods.

PHASE II: Build a prototype application of the equipment or software. Demonstrate the advanced technology under actual engineering conditions.

POTENTIAL COMMERCIAL MARKET: Improved performance and safety of commercial and private aircraft will be realized with application of this technology. New areas of commercial growth will result from aircraft design tools which allow fast and accurate development of vehicles to respond to aircraft needs throughout the world. Examples are devices which allow aircraft to operate from remote fields, carry large payloads at low cost, and are economical to produce and operate. New aerodynamic analysis tools will improve education methods and allow industry to produce with lower initial investment. Advanced experimental methods are applicable to more efficient ground transportation systems.

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Lewis REsearch Center, Cleveland, Ohio; May 1995.
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3. "Viscous Drag Reduction in Boundary Layers," Bushnell, D.M., and Hefner, J.N.; Progress in Astronautics and Aeronautics, Vol 123, 1990.

END OF TOPIC

POINT OF CONTACT: Val Dahlem, (513) 255-6165, dahlemvi@wl.wpafb.

AF97-149 TITLE: Fire Detection/Suppression Systems

OBJECTIVE: Develop advanced firefighting technologies that can significantly improve fire detector efficiency and increase fire suppressant performance.

DESCRIPTION: The Air Force has a critical need for improved fire protection capabilities. Firefighting is being revolutionized by increasing environmental concerns. Front-line fire extinguishing agents caused environmental concerns. Similarly, firefighter training with hydrocarbon fires has been severely restricted. Current fire detection systems cannot discriminate against all potential false alarm stimuli and have resulted in the loss of vital Air Force resources and costly cleanup operations. New environmentally safe and effective fire detection/suppression systems are required. Some of these areas include but are not limited to the following:

1. High Speed Suppression via Cold Inert Gas Generation - Fire extinguishment by inert gases is an effective means of protecting electronic and electric equipment. Large volumes of inert gases can be generated by thermochemical means to suppress potentially dangerous fires rapidly and effectively. This proposed research will develop a system that rapidly generates cold inert gases for rapid extinguishment of electronic/electric fires. 2. Optical Pre-warning Gas and Flame Detection - Current fire detection technologies generally depend on the presence of a flame before corrective action can be taken. An open path gas detection system that can provide early warning of flammable or toxic gas presence will significantly improve fire protection, safety.

3. Computational Fluid Dynamics Fire Suppression Systems Design Tools - The high cost of new fire suppression agents emerging from laboratory development makes medium and large scale testing of these agents in fire suppression delivery systems prohibitively expensive. This research will produce a set of design tools that can be used to design, at low cost, fire suppression delivery systems that incorporate current and future Halon 1301 and Halon 1211 replacements.

PHASE I: Development of preliminary design of cold gases and path detectors.

PHASE II: Build and test prototypes for field testing using results obtained in Phase I.

POTENTIAL COMMERCIAL MARKET: All commercial facilities and industries where rapid fire detection and suppression would increase the survivability of people and resources, including but not limited to the automotive industry, commercial cruise lines and/or other sea transportation, and any other industry where the use of high speed turbine engines are the primary source of power.

REFERENCES:

1. "Computational Fluid Dynamics Modeling of Fire Suppression Events," National Research Council (Canada), June 1993.
2. Fire Extinguishing Pyrotechnics "Proceedings of the Eighteenth International Pyrotechnics Seminar," Breckenridge, Colorado, p. 701, July 1992.

END OF TOPIC

POINT OF CONTACT: Juan Vitali, (904) 283-9708,

AF97-150 TITLE: Innovative, Localized, Autonomous Cooling Systems

OBJECTIVE: Develop localized, autonomous cooling system capable of dissipating large power densities with moderate cooling capacity.

DESCRIPTION: The increased performance, compact packaging, and variable operation cycles associated with future aircraft systems and retrofits of existing fleet aircraft systems lead to both increased power densities and transients. Additionally, these systems, which include actuators and electronic components, are being positioned in the extremities of future high performance aircraft. These trends necessitate the advancement of the state-of-art in localized or distributed cooling concepts that can meet the power densities associated with future electronics and the thermal transients pertaining to "on demand" systems. The cooling system must be "environmentally friendly" and compatible with lightweight aircraft structures and avionic equipment. It must also have affordability benefits and good producibility for practical application. It shall be capable of dissipating large power densities of up to 100 W/cm2 with moderate cooling capacities of up to 2 kW while being exposed to aircraft environments1.

PHASE I: During Phase I, analysis and conceptual design work will be performed to evaluate the heat transfer effectiveness and energy dissipations capability of the proposed localized, autonomous cooling systems. This analysis and conceptual design will also address the concepts compatibility with aircraft and electronic systems. The design will show sufficient technology maturity for orderly development into aircraft systems with compatible environmental factors. The Phase I work will produce a competent technical report and plans for experimental development in a proposed Phase II effort.

PHASE II: This phase continues the necessary analytical work and provides experimental verification of predicted heat transfer capability for the localized cooling system. Laboratory simulation of typical operating conditions will evaluate performance at different temperature and power conditions. Any environmental restrictions will be assessed. Benefits to be gained from the use of the heat transfer system will be quantitatively established for different potential applications to prepare for possible commercial development of the system. A competent technical report will document all of the work conduct, a final optimized designed will be completed, and an optimized localized cooling system will be fabricated.

POTENTIAL COMMERCIAL MARKET: Dual use commercialization will be considered in all phases of this effort. Commercial markets could include commercial aircraft, large machinery for

agriculture and transportation, electronics, and automobiles.

REFERENCES:
1. Mil-Std-810D, "Military Standard Environmental Test Methods and Engineering Guidelines."
2. "The Development of Advanced Cooling Methods for High Power Electronics," T.J. Bland, et al., SAE Paper 9011962, Presented at the SAE Aerospace Technology Conference and Exposition, Long Beach CA, October 1-4, 1990.
3. "Developing New Miniature Energy Systems," R.S. Wegeng and M.K. Drost, Mechanical Engineering, September 1994, pp. 82-85.
4. "Cooling of Electronic Boards using Internal Fluid Flows," K.E. Herold, S. Sridhar, and S. Hu, Proceedings from the First Joint ASME/JSME Conference on Electronic Packaging, Milpitas CA, April 9-12, 1992, pp. 285-290.

END OF TOPIC

POINT OF CONTACT: David Pratt, (513) 255-0251, prattdm@b045mail.

AF97-151 TITLE: <u>Spall Fragment Field and Surface Deformation Characterization System</u>

OBJECTIVE: Develop a quantitative spall fragment field and surface deformation system.

DESCRIPTION: This effort involves the development of a quantitative means of recording the spall fragment field and surface deformations produced by projectile penetration of composite materials. The system will be used by Wright Laboratory to characterize the fragment field's kinetic energy distribution (i.e., particle size and velocity vector distributions) and threat-target interactions resulting in surface deformation. Required system capabilities include quantifying the dynamics of selected individual fragments over a protracted period of time, together with characterizing the deformation (or velocity) history of target surfaces. Spall fragments having cross-sectional dimensions in excess of 10 microns and lengths in excess of 100 microns must be discernable. Fragment velocities are dependent on proximity to the impact location and can be as high as 3 km/s. Surface observations must span a minimum area of 100 square centimeters, with a lateral (spatial) resolution of 1 mm (i.e., 10,000 measurement locations per time step). The axial resolution requirement, with respect to the shotline, is 100 microns over a deformation range of 1 centimeter. Several user-selected time steps are desired. Time step intervals will vary from 1-500 microseconds. Quantitative measurements will be used to validate first-principles-based algorithms for composite penetration.

PHASE I: A prototype system will be designed to quantify impact-generated surface deformations and spall fragment fields. The design will be supported numerically and through proof-of-concept tests.

PHASE II: A turn-key prototype system will be developed, tested, and delivered. The system will be capable of quantifying the dynamics of selected individual fragments over a protracted period of time and characterizing the deformation history of target surfaces.

POTENTIAL COMMERCIAL MARKET: As composites are introduced into commercial and consumer products, a system that characterized energy dissipation mechanisms and mass loss (as a result of collision, impacts, and/or explosions) is need ed to characterize the hazard and evaluate safety issues. Targeted commercial organizations are damage resistant material manufacturers serving the optical, automotive, marine, and aviation industries.

REFERENCES:

1. Nebolsine, P.E., et al., "Shadowgraphic Holography Analysis

for Debris Characterization," SPIE Conference 2214, Space Instrumentation and Dual Use Technologies, Orlando FL, April 1994.

END OF TOPIC

POINT OF CONTACT: Greg Czarnecki, (513) 255-6052, czarnegj@wl.wp

AF97-152 TITLE: Engineering Research Flight Simulation Technologies

OBJECTIVE: Develop innovative flight simulation techniques which support research for advanced aircraft.

DESCRIPTION: The Air Force is interested in new flight simulation technologies which support flight control or aircraft system development for advanced aircraft. The Air Force seeks simulation technologies that support a small number of high fidelity entities interacting in a virtual research environment. Technologies that optimize aircraft fidelity between local and long haul network entities are needed to support training applications. Novel display technologies, lower life cycle cost simulation techniques, or improved techniques for conducting research using networked simulation are of interest. Application of commercial virtual reality technologies to simplify research simulation is encouraged so long as simulation can be maintained at a high fidelity. Innovative approached for the use of large High Definition Television (HDTV) Cathode Ray Tubes (CRTs) or flat panel displays in flight simulator instruments and projection systems for visual displays are of interest. Improvements will be considered for any technology, hardware device, or software program/architecture that shows potential for flight simulation advancement.

PHASE I: Shall define the proposed concept, investigate alternatives, and predict performance of the proposed design. Demonstrations of high-risk portions of the design are encouraged, but not required.

PHASE II: Shall fully implement, demonstrate, and test the Phase I design. Results of the test and recommendations for improvements and/or alternatives shall be documented.

POTENTIAL COMMERCIAL MARKET: Improvements in flight simulation technology have application to flight simulators used by the airline industry to satisfy FAA training requirements. Flight simulation technologies can also be applied to the expanding fields of virtual reality, medicine, manufacturing, and entertainment.

REFERENCES:
1. Full Mission Simulation for Research and Development of Air Combat Flight and Attack Management Systems; Goddard & Zeh; AGARD-CP-513; 1991. ADP 006 863.
2. Dynamic Latency Measurement Using the Simulator Network Analysis Project (SNAP); Bryant et al. IITSEC; 1994.

END OF TOPIC

POINT OF CONTACT: Ron Ewart, (513) 255-4690, ewartrb@wl.wpafb.af

AF97-153 TITLE: Innovative Damping Concepts for Extreme Environments

OBJECTIVE: Develop damping concepts for structures subjected to high temperatures, centrifugal loading, and other extreme environments.

DESCRIPTION: Although there are a number of relatively mature technologies associated with damping non-rotating structural components at temperatures below 500 degrees Fahrenheit, there is a critical need for damping concepts appropriate for applications that are subjected to high temperatures, centrifugal loads, and other extreme environments. Existing polymeric viscoelastic damping materials are only effective over narrow temperature range, and become susceptible to creep when exposed to elevated temperatures and/or when subjected to large steady state loads. For extreme environments, damping concept using polymeric materials must include some sort of innovative scheme to address these problems. Alternative approaches to the use of polymeric viscoelastic materials may be identified for the damping concept, and damping treatments that are relatively insensitive to temperature would be very useful in may applications. An analytical model that can be used in the design of the damping treatment is required so that the damping design will not be based on an empirical "trial and error" approach. The damping treatments may be designed for specific extreme environment applications of interest to the Air Force, including engine nozzles, hypersonic or exhaust washed structures, and rotating components within air vehicle engines. One application of special interest is the damping of aircraft turbine engine blades, which supports research to reduce the effects of high cycle fatigue (HCF) in aircraft engines.

PHASE I: Must demonstrate the feasibility of the damping concept, including its compatibility with elevated

PHASE II: The damping treatment must be fabricated and then tested to demonstrate its effectiveness in the application considered. The testing must effectively demonstrate the damper's durability in the environment for which it is designed. The Phase II must also demonstrate that the treatment can provide effective damping without adding excessive weight, cost, or maintenance requirements.

POTENTIAL COMMERCIAL MARKET: There are several commercial markets for damping technologies that are capable of withstanding elevated temperatures and large steady state loading, including vibration isolation devices for heavy machinery. Damping concepts can also be used in the commercial aircraft and automotive industries to reduce undesirable vibration in structures and engines. Added damping reduces resonant response, which reduces requirements for maintenance

and enables the development of lighter weight, higher performance turbine engines. Large turbines are also used in the power generation industry, which could realize similar benefits.

REFERENCES:

1. Soovere, J & M. L. Drake. (1984). Aerospace Structures Technology Damping Design Guide, Volumes I-III. Report number AFWAL-TR-84-3089, Flight Dynamics Laboratory. Available through DTIC; Volumes I-III: ADA-178313, ADA-178314M ADA-178315.

END OF TOPIC

POINT OF CONTACT: Capt Kimberly B. Demoret, Ph.D, (513) 255-5200

AF97-154 TITLE: Bare Base Operations

OBJECTIVE: Develop lightweight, air transportable Bare Base support systems that significantly improve existing and/or new Bare Base capabilities.

DESCRIPTION: The Air Force has a critical need for improved mobile, air transportable support systems to expedite and sustain aircraft operations and personnel beddown during contingency operations. These new systems must be smaller in size, lighter in weight, rapidly deployable, and provide capabilities to improve system operations, reduce operating cost and manpower. These new systems must be smaller size, lighter in weight, rapidly deployable, and provide capabilities to improve system operations, reduce operating cost and manpower. There are significant opportunities through application of advanced technologies to achieve measurable results in many key areas. Some of these areas include but are not limited to the following:

1. Efficient Waste Processing and Disposal Plant - Currently Bare Base waste is disposed of by liquid waste pumpers. This poses severe penalties in airlift volume in deployments, such as Desert Storm, Guantanamo and Somalia. This proposed novel research is to develop an air mobile waste disposal plant which minimizes weight and volume of current waste systems.

2. Advanced Integrated Mobile Power Generation Systems - Existing Bare Base power generation systems are heavy, bulky, and require significant airlift. Use of new cryogencially cooled superconducting materials will enable the development of a generator one-quarter the size and weight of current assets. The application of superconductivity technology can revolutionize mobile power generation.

3. Hybrid Dual-Fluid Environmental Control Units - Mobile base environmental control units (ECUs) protect personnel from harsh climates. Present day ECUs use banned ozone depleting chemical (ODC0) R-22. The proposed research will develop a new generation of ECUs that replace ozone depleting fluorocarbon refrigerants on both fixed and mobile AF installations. 4. Pavements Creation From In-Situ Materials - Air Force forward and contingency bases require additional parking capability to meet mission requirements. The proposed research will develop methods to rapidly create aircraft operating surfaces using insitu solid materials. Target time-frame for construction of a 150ft by 150ft parking apron is 8 hours.

5. Air Mobile Shelters - The Air Force has requirements for innovative concepts for a new generation of air mobile shelters. The shelters must minimize weight, packing volumes, and assembly times, support snow loads, wind loading, and be capable of long term storage. Life cycle costs, energy efficiency and potential for chemical/biological protection are also areas of interest.

PHASE I: Identify and laboratory test a proof of concept.

PHASE II: Will include the transition of individual components into an optimization process whereby a module assembly will be fabricated and tested.

POTENTIAL COMMERCIAL MARKET: Technologies used to develop improved Bare Base equipment will be developed jointly with industry and have direct application to DoD and commercial sectors (utility, transportation and aircraft industries).

REFERENCES:

1. Bare Base Conceptual Planning Guide, AFPAM 10-219, 1 February 1995.

END OF TOPIC

POINT OF CONTACT: Kevin Grosskopk, (904) 283-3732,

AF97-155 TITLE: Advanced Aircraft Coatings Systems

OBJECTIVE: Develop approaches for a fundamental understanding leading to advanced aircraft coating systems capable of satisfying operational requirements over a service life of 30 years.

DESCRIPTION: Aircraft painting/stripping/repainting processes and handling the associated hazardous waste is one of the highest cost maintenance activities in the Air Force. As a result, in late 1993 a USAF Paint Technology Task Force was chartered to establish a strategy for the Air Force paint removal and coating systems of the future. The Air Force Coating System Strategy applies to almost all operational aircraft and identifies aircraft coating system requirements from now until beyond the year 2003. In addition to environmental compliance, the strategy clearly defines long term coating system performance parameters significantly beyond the current state-of-the-art. An advisory panel of internationally recognized experts in the fields of coating technology and corrosion science and engineering, from industry and academia, was chartered to study the potential of a basic research contribution to ameliorate the aircraft paint issue leading to recommendations for a programmatic course of action. As result of that study, the following four areas of basic research activity were identified as enabling for the Air Force to meet its stated objectives by the year 2003.

1. Investigation of synthesis/structure/property relationships for surface treatments, primers and matte topcoats.
2. Identification of degradation mechanisms of polymers in matte coatings and subsequent development of appropriate models for performance predictions.
3. Synthesis of advanced materials (polymers, additives, pigments, inhibitors) for new coating systems.
4. Development of nondestructive evaluation (NDE) for under-coating inspection and coating health monitoring.

The Air Force plans to establish basic research programs in each of the above enabling technology areas with participation by the top researchers in the country. Although there are ongoing activities to address environmental compliance, AF requirements are unique in the areas of 30-year life and removal/reapplication of topcoats. Current national and international research activities in the above areas lack a "fundamentals" approach, are somewhat unfocused and do not address requirements unique to the Air Force. Research and development programs are sought which address the unique operational requirement of 30-year life.

PHASE I: The establishment of viable approaches to

addressing key elements of the above enabling technologies are sought in Phase I.

PHASE II: Follow-on efforts in Phase II will further develop and optimize the elucidation of mechanisms, development of models, synthesis of advanced materials and/or development of NDE techniques using the approaches established in Phase I.

POTENTIAL COMMERCIAL MARKET: The commercial aircraft industry will benefit because much of the technology developed will be directly applicable. The auto industry also has a great need for corrosion protection as well as a need for predicting and extending the life of coatings for cars and trucks.

REFERENCES:

1. Report, "AF Blue Ribbon Advisory Panel on Aircraft Coatings, Part 1, Basic Research," prepared by Universal Technology Corporation for WL/ML and AFOSR, November 1995.

END OF TOPIC

POINT OF CONTACT: Dr. Michael Donley, (513) 255-6485, donleym@ml

AF97-156 TITLE: <u>Environmentally Compliant Aircraft Coatings</u>

OBJECTIVE: Develop low/zero-VOC materials and/or application techniques suitable for aircraft coatings.

DESCRIPTION: The Air Force is interested in conducting exploratory development of aircraft coatings with a minimal detrimental impact on the environment. Most coatings now used by the Air Force release large amounts of volatile organic compounds (VOC's) into the atmosphere, producing smog or other air pollution. Some coating formulations include hazardous components (EPA 17, lead, chromates, etc.). Some of the new coatings for low speed and high speed aircraft, which meet the environmental standards, suffer an unacceptable loss of properties such as adhesion, durability, cleanability, optical signature control, and affordability. The Air Force has a durability goal of 8+ years. New materials and/or application systems that can greatly reduce or eliminate VOC's and other undesirable materials, while controlling the aircraft's spectral and diffuse infared signature, are necessary in order to comply with stringent environmental regulations, either currently in effect or likely to be enacted in the near future. Relevant technologies for low/zero-VOC coating development include, but are not limited to, high solids coatings, waterborne coatings, powder coatings, plasma/thermal spray systems, and appliqués.

PHASE I: Phase I will address initial formulation, fabrication, evaluation, and application techniques of specific subjects for proof of concept.

PHASE II: Phase II will further develop and optimize the material and/or application techniques, and produce larger samples for a full spectrum of evaluations.

POTENTIAL COMMERCIAL MARKET: The requirement to comply with environmental regulations applies equally to the commercial coating industry. As such, much of the technology developed for compliance of military coating systems could be extended to commercial applications. Commercialization of the technology would involve scale-up to production capacity, and production of sufficient quantities of material to coat aircraft or other large objects using an environmentally compliant and commercially viable application technique. Additionally, opportunities for commercialization in the solar energy field exist.

REFERENCES:

1. AFWAL-TR-86-1028, "Camouflage Handbook," April 1986.
2. Title I of the Clean Air Act Amendments of 1990 (CAAA).
3. California South Coast Air Quality Management District Rule 1124

END OF TOPIC

POINT OF CONTACT: Lt Rob Passinault, (513) 255-4611, passinrj@ml

AF97-157 TITLE: Affordable Composites

OBJECTIVE: Develop low cost materials and processes for carbon fiber composites.

DESCRIPTION: The Air Force is seeking new and highly innovative concepts for affordable carbon fiber composite materials and processes utilizing polymeric and/or carbon matrices. These concepts are for aircraft, spacecraft, automotive, and/or electronic applications. Concepts on near net-shape manufacturing, integrated structure, low cost coatings, and low cost raw materials and processes are sought. A large cost driver in producing parts from advanced composites is from machining after the part is processed. Near net-shape manufacturing can help to reduce costs due to machining. The cost of labor to assemble many parts to build a structure affects composite costs. Integrated structure would reduce part count, thereby reducing assembly time. For some composite materials, a faster processing time or reduces step processing would eliminate some composite costs. Low cost coatings for use in the 1000 or 1200°F temperature regime could greatly increase the number of applications utilizing carbon fiber composite materials. Finally, high material costs keep carbon fiber composites from being fully utilized in applications such as automobiles and electronics. Low cost raw materials can help to expand the use of carbon fiber composites.

PHASE I: The Phase I program must demonstrate the feasibility and cost savings of the proposed concept sufficiently to justify further development and/or scale-up in a Phase II effort. Proof-of-concept subcomponents should be fabricated and tested.

PHASE II: The concepts demonstrated in Phase I will be scaled up and developed in detail. The payoffs and benefits of the technology will be demonstrated by fabrication and testing a component.

POTENTIAL COMMERCIAL MARKET: Affordable carbon fiber composites will provide technologies for commercial transportation vehicles, sporting goods, electronic modules, and civilian infrastructure such as composite bridges. Extreme environment composite technology (high temperature, stress, and/or vibration) will have extensive applications for internal combustion, turbine engines, nuclear reactors, and incinerators.

REFERENCES:
1. 40th International Society for the Advancement of Materials and Process Engineering (SAMPE) Symposium, Anaheim CA, 1995.

END OF TOPIC

POINT OF CONTACT: John D. Russell, (513) 255-1471, russeljd@ml.w

AF97-158 TITLE: Polymer/Inorganic Nanocomposites for Substructure Applications in USAF Rockets and Aircraft

OBJECTIVE: Develop a new generation of polymer-matrix nanocomposites for use in substructure applications in USAF rockets and aircraft.

DESCRIPTION: New high-use temperature, lightweight polymeric materials shall be required in future airframes and rockets to enable the optimum performance characteristics of the systems. Recently, a new generation of polymer-matrix nanocomposites has been developed based on the molecular-level dispersion of highly anisotropic, inorganic nanoscale rods or plates, such as mica-type layered silicates, in a thermoplastic polymeric resin. These new polymer-matrix nanocomposites exhibit superior mechanical characteristics (e.g. 100% increase in the heat distortion temperature) and chemical resistance (e.g. ~ 10 fold decrease in 02 and H20 permeability) compared to the neat resins. These property improvements raise the use-temperature and extend the potential use-environments of the polymeric material. Additionally, in contrast to conventional filled-polymer systems where inorganic loadings are greater than 30 wt%, these nanocomposites contain less than 10 wt% of the inorganic. Thus, the overall weight of the nanocomposites is less than that of conventional composites and the impact strength of the nanocomposites is less than of conventional composites and the impact strength of the nanocomposites is not drastically decreased with respect to that of the neat resins. These impressive properties are believed to be related to the homogenous nanoscale dispersion of the highly anisotropic nanoscale inorganic phase. In contrast, conventional filled resins and composites utilize inorganic fillers on the micron or larger scale, such as talc, kaolinite, carbon black, glass fiber and carbon fiber. This technology has yet to be explored for potential Air Force applications. These materials may replace current composites and filled polymer materials in substructure applications, such as trusses, in rockets and aircraft resulting in a weight and cost savings. Also, these nanocomposites could replace nonpolymeric materials in some noncritical structural applications such as fuel-line brackets, stirred combustion chambers and cryogenic storage containers, again resulting in weight and cost savings. New economically-viable, preferably nonsolvent based processing techniques are sought which retain or improve the nanoscale dispersion and global alignment of the inorganic phase and result in polymeric-matrix nanocomposites with superior mechanical, thermal and chemical properties. Additionally, the development of new economically-viable inorganic constituents that are dispersible as nanoscale plates or rods in a variety of commercially available thermoplastic resins and that are more thermally

stable than current commercial material will also be considered.

PHASE I: The goal of the Phase I effort is development of at least two potential thermoplastic resin/inorganic constituent nanocomposite systems. Emphasis should be placed on potential nanocomposite systems from (1) elevated use-temperature thermoplastics (i.e > 175°C, long term) and (2) ultra high use temperature resins (i.e. > 250°C, long term) such as aromatic heterocyclic rigid rod polymers.

PHASE II: The polymer-matrix nanocomposite with the most promising combination of mechanical, thermal and chemical properties will be selected, and continued technical work shall require the fabrication of commercially viable specimens in the form of films, fibers and molded components.

POTENTIAL COMMERCIAL MARKET: Commercial applications would include structural components in automobiles, replacement of current filled polymer systems in automobiles, replacement of conventional fiber composites such as fiber glass, and packaging materials such as films and containers for foods which require low permeability and recyclabilty.

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2. Maxfield, M., et al., International Patent (PTC), C08K3/34, c08L77/00, 23/02, (1993).
3. Vaia, R.A.; Tse, O.; Giannelis, E.P., U.S. Patent pending, Serial # 08-158,249 (29 Nov 1993).
4. Kojima, Y., et al., J. Polym. Sci: Part A: Polym. Chem. 1993, 31, 983.
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6. Vaia, R.A., et al., Adv. Mater., 1995, 7, 154.
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8. Messersmith, P.B., Giannelis, E.P., J. Polym. Sci.: Part A: Polym. Chem., 1995, 33, 1047.
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END OF TOPIC

POINT OF CONTACT: Richard A. Vaia, (513) 255-9184, vaiara@ml.wpa

AF97-159 TITLE: Improved Tribological Systems for Spacecraft

OBJECTIVE: Develop methods to extend spacecraft useful life up to 15 years from limits imposed by existing tribological systems.

DESCRIPTION: Existing spacecraft utilize lubrication systems that have not been optimized for long life and low torque and wear. There is a general reluctance to change a lubricant and/or bearing surface finish to new materials that are known to be superior, but have not been "space proven." However, as the size of spacecraft is getting smaller and the time in space is lengthened, more severe demands are placed on the tribological systems. Lubrication failure is more and more often the cause of satellites becoming useless in space as the bearings and other mechanical parts lock up following lubricant depletion. NASA Lewis Research Center has been organizing the tribological experiences of spacecraft in the form of a handbook, but the ranking of the needs for tribological research and development needs to be established with the highest payoffs targeted for testing and improvement. Materials Directorate, Wright Laboratory has been conducting R&D on new base fluids and on additives for these and existing base fluids and on new tribological coatings for wear surfaces. Base fluid general classes of interest (because they are in existing systems) include hydrocarbons and perfluoropolyalkylethers. Silahydrocarbon base fluids offer excellent improvement in reduced torque and low volatility compared to other hydrocarbons. Low volatility additives have been found to reduce friction and wear over the base fluid. Greases made from silahydrocarbon are needed to take advantage of the excellent properties of the base fluid. Materials Directorate has also developed improved coating materials, including WS2, Cfx, CNx and TiN, applied by different state-of-the-art techniques, including magnetron sputtering, pulsed laser deposition and cathodic arc deposition. These are improved bearing/race coatings to potentially improve the life of space bearings. Improvements in currently used familiar materials will have greatest acceptance to potential uses of new technology. The greater the involvement of Aerospace Corporation, NASA, satellite and spacecraft component suppliers, satellite and spacecraft manufacturers, tribological experts and government agencies, the greater anticipated acceptance by the space community.

PHASE I: Identify most critical needs in space system tribology. Incorporated improved base fluids and additives and coatings from Materials Directorate programs and from industry into optimized lubricants, greases and coatings. Develop a standard for liquid/grease "outgassing" to overcome the shortcomings of current methods developed for structural materials.

PHASE II: Based on input from the space community, fabricate an operating mechanism to demonstrate the various lubricants and coatings to simulate the life characteristics of a space mechanism. Thoroughly assess the strengths of various lubricant systems identified in Phase I towards the goal of up to 15 years life in spacecraft mechanisms.

POTENTIAL COMMERCIAL MARKET: Since many spacecraft are commercial as well as military, the knowledge gained and demonstrated from this program on extension of mechanical system life and weight reduction through elimination of redundant mechanisms will easily transfer to commercial spacecraft.

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END OF TOPIC

POINT OF CONTACT: Lois Gschwender, (513) 255-7530, gschwelj@ml.w

AF97-160 TITLE: Paint Stripping Methods

OBJECTIVE: Develop innovative process for stripping paint -- completely and selectively -- from aircraft.

DESCRIPTION: The Air Force is interested in new innovative ways to strip aircraft. The primary method of removal was application of methylene chloride which was a labor intensive process and under current regulations is environmentally unacceptable. Currently, plastic media blast materials and water technologies have been emerging at Air Logistic Centers, but there is still concern over disposing of spent materials, cost of systems and their operations, and strip rates. New technologies are sought that will eliminate environmental concerns, reduce labor, and be nondestructive to the skin of the aircraft over its lifetime. The technology should be able to strip the coating system completely (primer and topcoat), but also be able to demonstrate selective stripping as well (topcoat only leaving primer intact). The stripping process should focus primarily on aluminum 2024-T3 alloy as the substrate with a small emphasis on composite materials, and the system should be a feasible and realistic transition to existing Air Logistic Center's support facilities. Some technologies sought but are not limited to are new water technologies, energetic stripping methods, newly developed plastic blast materials or wheat starch materials. These systems must reduce or eliminate HAZMAT disposal fees, be cost competitive in production of the apparatus and in its operation, be able to strip a majority of the aircraft, and meet/exceed current strip rates.

PHASE I: Phase I will entail the initial design and development of the paint stripping method with some preliminary evaluation on strip rates and ability to completely and selectively strip paint systems.

PHASE II: Phase II will further develop and optimize the stripping process and produce a prototype stripping apparatus. Larger parts representing aircraft components will be stripped to evaluate strip rates, selectively of stripping process, and ease of application used.

POTENTIAL COMMERCIAL MARKET: This has the potential to be used commercially due to the impending environmental regulations. Stripping of aircraft is essential in inspecting the skin of the aircraft and this process must be done faster, cheaper, and more environmentally responsible than what we use in current practice. All aircraft operators and manufacturers will have a vested interest in this technology if they plan on keeping aircraft more than 7 years.

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END OF TOPIC

POINT OF CONTACT: 1LT Lance B. Reynolds, (513) 255-8097, reynoll

AF97-161 TITLE: Gap Treatment Materials for Low Observable Aircraft

OBJECTIVE: Develop a rapid-cure conductive sealant for gap treatments.

DESCRIPTION: Many of the Air Force's current and planned aircraft employ low observable or "stealth" technologies. One critical component of these technologies is the treatment of the gap formed at the surface of the aircraft between structural components and access points. The nature and function of the gap requires a material that is flexible and electrically conductive, properties which are mutually exclusive. Due to the physical requirements, current gap materials tend to have low reliability, are difficult to apply and repair, and have special storage requirements. The Air Force is seeking to develop a gap treatment material which is reliable, has a short cure cycle, is easily stored and applied, and can be easily repaired. The traditional approach has been to fill an elastomeric sealant with conductive particles. Unfortunately, achieving a minimal cure time for a highly filled conductive sealant is very difficult due to the solvents required to process the system. Potential approaches to meet the rapid-cure concept include ultra-violet light, induction heating, and electron-beam curing matrix systems or other methods that use little or no solvents.

PHASE I: The Phase I program must demonstrate the feasibility and cost savings of the proposed concept sufficiently to justify further development and/or scale-up in a Phase II effort. Proof-of-concept subcomponents should be fabricated and tested.

PHASE II: The concepts demonstrated in Phase I will be scaled up and developed in detail. The payoffs and benefits of the technology will be demonstrated by fabrication and testing a component.

POTENTIAL COMMERCIAL MARKET: Reliable and maintainable gap treatment materials could readily be used in many areas where conductive caulks or sealants are required. Markets include electronic shielding, dissipation of electrostatic charge in computer assembly, flexible attachment for wiring and hybrid circuitry, and construction.

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END OF TOPIC

POINT OF CONTACT: David L. Ciminelli, (513) 255-9728, ciminedl@m

AF97-162 TITLE: Affordable Multi-Material System Alternatives

OBJECTIVE: Develop thermal, mechanical, and /or chemical process design of alternative near net-shape processes for difficult-to-form materials.

DESCRIPTION: Materials insertion applications and spare components for aging aircraft systems offer tremendous opportunity to introduce innovative methods, processes and material systems to reduce weight and costs while improving wear, temperature and strength performance. The need is for material process design methods which consider alternative processing which lead to significant reduction in design and fabrication times. Of particular interest is the design and fabrication of precision tooling to enable materials substitution or replacement components that are lighter, stronger and less expensive than might be otherwise attained through conventional forging, casting and machining operations. Demonstration of reduced part turnaround and delivery with cost savings of 50% are a targeted goal. Methods, processes and materials should be functionally integrated via a feature-based design environment allowing selection and optimization of manufacturing methods, processes, and materials for structural aircraft and engine components.

PHASE I: Demonstrate feasibility of embedding analytical models of basic transport phenomena such as thermal, mechanical, and chemical processes into computer-aided design system with geometric modeling and feature-based design environment capability. Develop a protocol for adding material and process models and a design feature library for storing them. Using an aircraft component such as a turbine blade, verify process design system capabilities by evaluating and comparing different manufacturing methods.

PHASE II: Develop a prototype design system for exploring different thermal, mechanical, and/or chemical processes for effectively producing near net-shape components composed of difficult-to-form materials. Verify the process design system by comparing the feasibility and cost benefits of alternative types of physical processes, namely hot forging, investment casting, reaction-based forging, and reaction-based squeeze casting for certain turbine engine and structural components.

POTENTIAL COMMERCIAL MARKET: Dual use of this exploratory research is foreseen for integrated shape, material, and process design of high performance metals, ceramics and polymers. Aircraft and automobile propulsion system vendors providing tooling for forming new higher temperature alloys.

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END OF TOPIC

POINT OF CONTACT: Dr. James M. Malas, (513) 255-8787, malasjm@ml

AF97-163 TITLE: Gradient Materials Interface Design

OBJECTIVE: Modeling and simulation of the interface design of gradient bulk and thin-film materials.

DESCRIPTION: The widespread application of gradient materials in areas ranging from biomimetic and mechatronic materials for nondestructive sensing and micro-actuation, to nonlinear optical properties for threat and detection, and to multilayer films for unique combinations of properties is limited by the lack of a design environment. Future material systems will require a design environment for modeling and simulating gradient thin-film interfaces including thin-film to bulk materials interfaces across monolithic and composite materials. Of particular interest is the ability to enable the integrated design of bulk components comprised of monolithic alloys and/or polymer, metal, and ceramic matrix composites whose properties are enhanced by interfacial effects and/or multilayer thin-film coatings. Although computational materials science approaches offer the potential for such a design environment, innovative approaches are sought to mitigate computational complexity and cost issues.

PHASE I: Demonstrate the tractability of approach relative to the design of the structure and composition for a given performance envelope (thermal, strength, magnetic and electro-optical properties) of multilayer film interfaces, i.e., inter-layer and film-to-substrate. Materials of immediate interest are replacement components for aging aircraft to include high temperature intermetallics, composites, and inorganic and polymer based electro-optical materials.

PHASE II: Develop a generic capability to design the structure and composition of a multi-layer film together with the ability to evaluate the performance (thermal, strength, magnetic and optical properties) of the combined film and substrate.

POTENTIAL COMMERCIAL MARKET: Dual use of this exploratory research is foreseen for integrated shape, material, and process design of high performance aerospace metals, ceramics and polymers. Aircraft and automobile propulsion system vendors providing multilayer films for component thermal and wear protection.

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END OF TOPIC

POINT OF CONTACT: Dr. Steven R. LeClair, (513) 255-8787, leclais

AF97-164 TITLE: Advanced Materials & Processes for Aging Aerospace Systems

OBJECTIVE: Develop novel materials and processes to extend service life of aging weapon systems.

DESCRIPTION: The many aerospace weapons systems in the Air Force inventory are being asked to perform ever-longer periods of service as the number of new weapons systems is reduced. Examples of these systems include aircraft structures, propulsion, electronics and optics, hydraulics, seals, sealants, and coatings. Novel materials and processes are needed to extend the life and reduce the cost of operating these systems. Due to the large variety of weapons systems, technical approaches should focus on concepts that would address more than one if possible. This is an exploratory development effort that would result in a materials and process feasibility demonstration with a clear path provided for further development to commercialization. Materials systems of interest would include both metallics and nonmetallics, monolithic and reinforced, and the related processes to produce, inspect, and simulate the effects of long-term aging.

PHASE I: A limited scope, concept verification phase that gathers enough experimental information to allow the original concept to be validated. Where possible the Phase I efforts shall utilize and compare findings with those obtained utilizing current materials and processes. The contractor shall include an engineering analysis of potential uses of the new technology for applications in various aging systems both military and civilian.

PHASE II: This phase will conduct much more extensive exploratory development materials and process verification efforts with heavy emphasis on comparisons through aging studies with existing materials and processes being used in the depot of field. Where possible, actual hardware and processing methods shall be utilized to validate the Phase I predictions. Lab level NDE and testing will be conducted on both the as-developed and artificially aged materials and related processes.

POTENTIAL COMMERCIAL MARKET: This effort should have significant dual use commercialization potential due to the extensive nature of aging infrastructure in the civilian economy. Improved metal alloys, composites, coatings, and other materials and processes should be broadly applicable to civil components.

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END OF TOPIC

POINT OF CONTACT: Tobey M. Cordell, (513) 255-9802, cordeltm@ml.

AF97-165 TITLE: Novel Nondestructive Evaluation Technology for Aerospace Components & Systems

OBJECTIVE: Develop new nondestructive evaluation (NDE) techniques that permits the detection and tracking of life limiting flaws in structural components.

DESCRIPTION: The Air Force is interested in research and development projects directed toward potential applications of new and novel NDE techniques to detect and quantify flaws in a range of components. Such a program should address the types of nature of a particular class of flaws and offer a method for their detection and quantitative assessment. Examples of the flaw types that are of interest include the very small flaws that result during high cycle fatigue, corrosion of aluminum aircraft structure, and the mapping of wide area fatigue damage in older aircraft. Another long standing NDE problem deals with the assessment of adhesively bonded components. Any work in this area must show that NDE measurements are applicable to well known models of adhesive joint performance. Such work must not be a simple correlation of performance with an NDE signal. An investigation of the trade-offs involved in the use of any proposed technique should lead to a rational engineering use philosophy for the technique. Special consideration will be given t those proposals that address materials that have both military and civilian applications, i.e., dual usage.

PHASE I: Programs in these areas should address the requirements and goals of the proposed efforts, as well as initial formulation, testing, and evaluation required for proof of concept.

PHASE II: The process or design concepts from Phase I would be developed through optimization and scale-up efforts to establish feasibility for manufacture and wide scale use of any instrument proposed. Either process or design concepts would lead to a marketable product after a Phase III program.

POTENTIAL COMMERCIAL MARKET: With the world wide emphasis on reliability and initial quality, the potential applications of new NDE techniques could be conceivably quite large.

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END OF TOPIC

POINT OF CONTACT: Robert L. Crane, (513) 255-9828, cranerl@ml.wp

AF97-166 TITLE: Metallic Structural Materials for Air Force Systems

OBJECTIVE: Develop, characterize, and model metallic structural materials.

DESCRIPTION: New approaches are requested to (a) develop and characterize gamma titanium aluminide intermetallic materials (up to 18000F); (b) characterize, understand, and model damage initiation and growth in metallics used in or proposed for use in turbine engines; and (c) develop continuous filament reinforced Ti-matrix composites with improved mechanical properties. For gamma titanium aluminide intermetallic materials, research is limited to (a) methods for modeling intermetallics which lend insight into chemistry selection and control, as well as microstructural selection and control; (b) methods of synthesizing gamma titanium aluminide to provide chemistry and microstructural control on a submicron scale while maintaining the ability to vary and control the final microstructural scale; and (c) methods for environmental protection of gamma (both monolithic and composites) aimed at providing long life under cyclic oxidation conditions. For damage initiation and growth in turbine engine metallics, proposals must describe new, innovative experimental test techniques and/or analytical modeling approaches for the characterization of life-limiting mechanical properties such as low cycle fatigue (LCF), fatigue crack growth, and creep/fatigue interactions. Special emphasis is placed on damage tolerance and high temperature, often time-dependent, properties, leading to the development of life prediction models. For continuously reinforced Ti-matrix composites, proposals must describe approaches for producing improved mechanical properties (damage tolerance, creep, and environmental resistance are mechanical properties of specific interest) and should focus on methods or concepts for control of interface properties of reinforcement, or control of matrix composition and microstructure.

PHASE I: This program will focus on the critical issues which when solved, will provide proof of concept for developing the materials, approach or methodology.

PHASE II: This program will be structured to develop and refine those feasible concepts to the point where an assessment could be made of the ultimate potential to help meet Air Force advanced materials needs.

POTENTIAL COMMERCIAL MARKET: The developed approach could have broad commercial applicability due to the large number of commercial aircraft and engine systems that have materials requirements of a very similar nature to those faced by the DoD. Various energy conservation applications, e.g., radiant burners, heat exchanger, and power turbines, are also pertinent.

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END OF TOPIC

POINT OF CONTACT: Jerry Petrak, (513) 255-1304, petrakgj@ml.wpaf

AF97-167 TITLE: High Temperature Structural Materials for Advanced Air Force Systems

OBJECTIVE: Develop and characterize advanced high temperature structural materials.

DESCRIPTION: New approaches are requested to develop and characterize (a) advanced high temperature structural ceramic composites (18000F to 35000F, excluding carbon-carbon composites), (b) intermetallic materials and composites (18000F to 30000F, excluding nickel aluminides) and (c) model forming processes for advanced structural materials. For ceramic composites, research is limited to continuous ceramic fiber reinforced ceramic matrix systems and may include the following: (a) new, unique ceramic composite development, (b) novel matrices suitable for continuous fiber reinforcement, (c) fiber/matrix interface treatments engineered for toughened behavior and stability, (d) continuous ceramic fiber development, (e) test techniques to determine mechanical and physical behavior (such as failure modes, crack and void growth, oxidation, stress-strain, cyclic stress-strain, etc.) as a function of temperature and loading history, and (f) analytical modeling of composite behavior. For intermetallic materials, research is limited to (a) methods for modeling intermetallics which lend insight into chemistry selection and control, as well as microstructural selection and control, (b) methods of synthesizing intermetallics to provide chemistry and microstructural control on a submicron scale while maintaining the ability to vary and control the final microstructural scale, and (c) methods for environmental protection of intermetallics (both monolithic and composites) aimed at providing long life under cyclic oxidation conditions. For modeling of forming processes, research may include modeling of (a) the unit forming process, (b) the material behavior in response to the demands of the unit process, (c) the interface between the work piece and the die or mold, and (d) novel methods for obtaining physical property data and constitutive equations for insertion in models.

PHASE I: This program will focus on the critical issues which, when successfully addressed, will provide proof of concept. Proposals should demonstrate reasonable expectation that proof of principle can be attained within Phase I.

PHASE II: This program will be structured to develop and refine those feasible concepts to the point where performance is demonstrated on a scale sufficient to permit an assessment of the ultimate application potential to help meet Air Force advanced materials needs.

POTENTIAL COMMERCIAL MARKET: The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have materials

requirements of a very similar nature to those faced by the DoD. Various energy conservation applications, e.g., radiant burners, heat exchangers, hot gas filters, and power turbines, are also pertinent.

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END OF TOPIC

POINT OF CONTACT: Dr. Allan P. Katz, (513) 255-9824, katzap@ml.w

AF97-168 TITLE: Design and Synthesis of New Bichromophore Laser Protective Materials

OBJECTIVE: Develop, design and synthesize new bichromophore laser protective materials

DESCRIPTION: The expanded use of lasers in many applications, including range finders and target designators, necessitates the protection of assets from accidental exposure. New linear and nonlinear materials are sought for use in protection schemes for use in the visible to near- infrared spectrum (0.4 to 2 microns). We are interested in new chromophores containing an optimized donor and acceptor, and a linking molecule with energy transfer between them. Indeed, recent recognition of the importance of advances in absorbing dyes and combinations thereof to address specific requirements and shortfalls, necessitates the application of predictive tools that address various aspects of advanced design, synthesis and characterization. Such a predictive capability is provided by an extensive application of computational methods ranging from ab initio quantum mechanical approaches, also including solvent effects, to semi-empirical techniques, and molecular mechanics/dynamics of large molecular systems for determining the structure of the linking molecule, and also with necessary modifications to address processability and solubility. The objective is therefore to apply computational-chemistry/materials science methods to predict structure and properties of existing and improved absorbing dyes, followed by synthesis and characterization. This objective is intended to lead to significant advances in bichromophore materials synthesis and processing, thereby permitting crucial changes in the design of optical systems that prevent damage during accidental or exposure to hostile laser radiation. Companies having both computational chemistry, dye synthesis and laser characterization expertise are encouraged to apply.

PHASE I: During this phase the proposer will design, synthesize and demonstrate material that has potential for laser protection.

PHASE II: Design, synthesize and characterize an expanded series of bichromophores based on proof of principle studies in Phase I.

POTENTIAL COMMERCIAL MARKET: This technology will have broad commercial applications involving lasers and will provide needed safety devices for worker protection. Materials would be commercialized by manufacturers specializing in laser protective eyeware.

END OF TOPIC

POINT OF CONTACT: Dr. Thomas M. Cooper, (513) 255-3803, coopertm

AF97-169 TITLE: Advanced Liquid-Crystal Materials Development

OBJECTIVE: Develop new liquid-crystal materials and processing technology to enhance their performance and utility.

DESCRIPTION: Devices based on liquid-crystal materials are being considered for use in a broad range of active and passive optical applications. Some examples of devices where liquid crystals are used include displays, electo-optic beam steering, active spectral filtering and solid-state shutters. The majority of the materials and process development effort internationally has focused on display applications, however, there are other applications for these materials in which there are distinct materials and processing technical shortfalls. The objective of this topic is to develop materials and/or processing techniques with enhanced performance over existing materials or enable liquid-crystal-based devices to be implemented in nonconventional environments or configurations. Examples of research and development areas appropriate for this topic include the development of materials or cell configurations with enhanced contrast over that currently available; materials which exhibit a broad nematic phase temperature range; guest-host dichroic dye technologies with dichroic ratio > 50; functionalized dye-liquid-crystal molecule development; processing technologies for liquid crystal cells which have curved geometries; high speed (< 1 ms) nematic liquid crystals which are intrinsic or geometry dependent; and, polymer-liquid-crystal composites. Proposals submitted to this topic should clearly address the applications where the device technology can be applied; however, the content of the program should focus on materials and process development - not device demonstrations.

PHASE I: During this phase the offeror will demonstrate the feasibility of the materials or process to satisfactorily demonstrate a proof of principle and identify those materials/process issues which must be addressed during Phase II of the program.

PHASE II: Optimize the materials and/or processes to achieve performance or capabilities not currently available. Design, fabricate and characterize a test article based on the developed materials or process which demonstrates an advanced in the state-of-the-art in liquid crystal technology.

POTENTIAL COMMERCIAL MARKET: Liquid crystal materials are employed in a wide range of commercial products such as portable computer displays, solid-state shutters and stereo viewers. Improvements in the materials and processing techniques will have broad applicability in numerous industries such as the display, entertainment and research product markets.

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END OF TOPIC

POINT OF CONTACT: Dr. Angela L. Campbell, (513) 255-3808, campbe

AF97-170 TITLE: High Temperature Superconducting Thin Films

OBJECTIVE: Develop advanced thin film processes to enable fabrication of HTS devices for electronic, microwave and opto-electronic applications.

DESCRIPTION: Significant progress has been made in the fabrication of high-quality high temperature superconducting (HTC) thin films since the discovery of these materials. However, critical materials and processing issues still need to be solved to fully use these films in a variety of device applications. Examples of issues considered appropriate for this program include the following: (1) thin films which have lower loss, better power handling and lower intermodulation products for advanced microwave devices, (2) improved SNS junctions and arrays of junctions with optimized and more uniform properties, (3) tunable HTS microwave filters, (4) textured buffer layers for growth of high-quality, biaxially-textured HTS films on polycrystalline substrates, and (5) HTS heterostructures for devices. This topic addresses the development of materials and processing techniques which will result in solutions to the above issues and increase the potential for successful application of HTS materials. Proposals should identify the potential application and its importance, identify the materials or processing problems which limit performance, and propose an innovative solution to these problems. Devices may be examined only for evaluating and demonstrating the techniques and materials which have been developed for successful fabrication of the devices.

PHASE I: Phase I will address process development and initial testing to demonstrate proof of concept. Delivery of a representative test sample or samples to the government is encouraged.

PHASE II: Phase II will develop and optimize the process or material to demonstrate the potential application and will plan for Phase III commercialization. Delivery of material samples to the government for testing is encouraged.

POTENTIAL COMMERCIAL MARKET: HTS materials technology has great potential for dual use and commercial applications. For example, HTS microwave filters could be used in wireless communication systems to alleviate growing cellular interference problems and improve frequency utilization. HTS SQUID based systems may find applications in the medical field for measuring magnetic signals from the heart, brain, and other organs. SQUID magnetometers may also be used for nondestructive testing of aging aircraft and other structural systems to find deep cracks and hidden corrosion.

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END OF TOPIC

POINT OF CONTACT: T. L. Peterson, (513) 255-4474, peterstl@ml.wp

AF97-171 TITLE: Nonlinear Optical Materials

OBJECTIVE: Develop nonlinear optical materials with superior properties as compared to those presently available.

DESCRIPTION: Nonlinear optical (NLO) materials are required for a variety of Air Force applications including electro-optic countermeasures. LIDAR, laser radar, optical signal processing, and optical interconnects. These applications require new laser sources (optical parametric oscillators and harmonic generators) and electrooptic devices (directional couplers, guided-wave interferometers, and optical phase shifters). However, presently available materials are unsatisfactory for many applications due to small nonlinearities, poor optical clarity, difficulty in processing for devices, and other factors. Proposed efforts shall address inorganic or organic materials in bulk or thin-film forms which exhibit large second-order nonlinear effects. Strongest interest is (1) in bulk crystals for frequency conversion to the 2- to 12-micron wavelength range including quasi-phase matched and periodically poled structures and (2) in thin films for guided-wave devices in the 0.7- to 1.5-micron range. Innovative techniques for preparing new materials or for improving the growth or processing of known materials are encouraged. Nonlinear optical devices may be examined only as a minor part of a materials effort to evaluate and demonstrate the properties of the material(s).

PHASE I: The objective is to demonstrate the proposed growth or processing techniques.

PHASE II: The objective is to develop advanced nonlinear materials and relevant processes to demonstrate potential.

POTENTIAL COMMERCIAL MARKET: Materials technology is fundamental to all applications, military and commercial. Examples of commercial applications for NLO bulk crystals are LIDAR for environmental monitoring, medical lasers, and scientific instruments. Examples for NLO thin films are optical switches for cable TV, optical phase shifters for phased array radar, optical interconnects for electronic packages, and switching networks for communications.

REFERENCES:
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END OF TOPIC

POINT OF CONTACT: F. Kenneth Hopkins, (513) 255-4474, hopkinfk@m

AF97-172 TITLE: Failure Mechanisms in Avionics Equipment Preventable by Dehumidification

OBJECTIVE: Determine what electronic components and materials within avionics assemblies change critical characteristics due to moisture.

DESCRIPTION: Significant design, development and testing work is expended to minimize moisture sensitivity of avionics. However many studies suggest significant improvements in the reliability when host aircraft are dehumidified. Most of the data sets collected have been simple summations of maintenance actions for one or more dehumidified, and a like number of very similar, non-dehumidified aircraft. Little or no data has been gathered which identifies the actual causes of degradation and failures dehumidification appears to prevent or reverse. The dehumidification studies have been performed on avionics built using traditional requirements/parts. These suggest dehumidification can apparently effect a 20% reliability improvement (indicating substantial moisture sensitivity), in assemblies using conformally coated hermetic parts. As mentioned, little of no information is available to explain the root causes of moisture sensitivity in older systems or those of more recent design. An additional complication is the trend away from traditional military hermetic parts. These parts are being replaced with technology families often more sensitive to moisture and other environmental stresses. A prime example is integrated circuits (ICs). Military standard ICs were required to be packaged in hermetic metal, glass, or ceramic. Many assemblies now in development include "commercial grade" plastic encapsulated integrated circuits. These have a well documented history of moisture sensitivity. Other examples are plastic encapsulated discrete semiconductors, non-hermetic capacitors, various resistors types, connectors, wiring, and printed wiring boards. When more moisture sensitive technologies are used, even more sensitivity assemblies can be expected. Physics-of-failure data is necessary to optimize dehumidification profiles (temperature, relative humidity, duration, etc.) to stop or reverse each mechanism by device type, or material. These then provide the basis for optimized profiles at system through aircraft levels.

PHASE I: Identification of the most inherently moisture sensitive components and assemblies. Proposals shall include information relevant to understanding the physics-of-failure mechanisms, rates of parametric and material property changes, and contributing factors for the part/material technologies (in rank order from most sensitive) commonly used in fielded assemblies and in common use for new design. While not recognized as sensitive at the piece-part level, these may become sensitive when exposed to manufacturing, use, and logistic support operations and storage conditions. Mechanisms

shall be categorized as either reversible or non-reversible by dehumidification. Laboratory and engineering characterization tests shall be performed as necessary.

PHASE II: Develop models which accurately identify assemblies sensitive to moisture related failure mechanisms (both intermittent and `hard' failures) under system operating conditions. The models shall identify moisture sensitive circuit locations based upon components/materials present in the assembly. For each sensitive component or material, a list of contributing factors, such as duration of exposure and onset thresholds, relative humidity, rate of parametric and material properties changes, and acceleration factors shall be provided. In addition, dehumidification process parameters (relative humidity, duration, etc.) necessary to stop or reverse parametric or materials changes shall be established for each sensitive technology family. The cost and mission consequences of moisture sensitive avionics assemblies shall be modeled based upon the presence of moisture sensitive technologies (identified in Phase I) on selected USAF aircraft. These models and analytic tools shall provide the capability to minimize moisture sensitivity of new assembly designs and to aid in locating and identifying root causes of moisture related failures (by circuit location) in aging aircraft avionics systems.

POTENTIAL COMMERCIAL MARKET: Both military and commercial designers benefit from identification of moisture sensitive technologies and the associated contributing and accelerating factors. This will improve first pass success in the design of moisture proof products, reducing development time and increasing customer satisfaction. This SBIR identifies opportunities for innovations in, and development and marketing of, less moisture sensitive parts and materials for use in both military and commercial products. With a knowledge of the sources of moisture sensitivity, an estimate of the maintenance burden attributable to moisture related mechanisms can be performed. This supports cost bendfit analysis required by system owner/operators in making decisions about the use of dehumidification or other alternatives. These capabilities also enable the acquisition community to choose among design alternatives to minimize moisture sensitivity of new assemblies. Operator benefits include identification of opportunities for reduced maintenance burden achievable by "desensitizing" aging equipment.

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1. Evaluation of Dry Air Dehumidification, United States Naval Air Systems Command Report No. SY50-88-044, September 1988.

END OF TOPIC

POINT OF CONTACT: David H. Johnson, (513) 255-3623, johnsodh@ml.

AF97-173 TITLE: Environmentally Benign Aircraft Deicing/Anti-icing Technology

OBJECTIVE: Develop an environmentally benign aircraft deicing/anti-icing agent.

DESCRIPTION: The use of glycols as aircraft deicers has come under scrutiny due to the Clean Water Act. Ethylene glycol is toxic and is no longer purchased by the Air Force for the purpose of deicing, while propylene glycol based deicers have a significant adverse environmental impact in surface and ground water from airfield runoff due to the high biological oxygen demand (BOD) of glycol degradation. Alternative materials are being sought to replace glycol-based aircraft deicers. The USAF is seeking to develop an environmentally benign deicing/anti-icing agent that eliminates or significantly reduces the BOD of airfield runoff, is nontoxic, noncorrosive to aircraft components, and cost-effective. Life Cycle Cost Assessment shall be included in each phase. This assessment will represent the systematic process in the life cycle by identifying environmental consequences and assigning monetary value.

PHASE I: Phase I research should require the development and testing of an alternative deicing material that demonstrates acceptable deicing/anti-icing performance (using SAW AMS 1424 and/or 1428 as a performance guideline), is noncorrosive to common aerospace materials, nontoxic, and environmentally acceptable. Included with this phase will be life cycle analysis for the alternatives. The approach to selection will be a rational design that includes computational prediction of properties i.e. toxicity and partition coefficient, understanding of icing mechanism as well as syntheses and testing of candidate materials.

PHASE II: Phase II should include the identification of a few candidates, further testing and development to support the performance and environmental acceptability of the deicing/anti-icing agent(s), as well as the fabrication and demonstration of a prototype delivery system to apply the material(s) developed for the purpose of deicing an aircraft. Included with this phase will be life cycle analysis of alternate agent(s), processes, system, or facility.

POTENTIAL COMMERCIAL MARKET: The proposed deicing technology would have broad applications in the civil aviation community as well as potential for cross-over into runway and roadway deicing applications.

REFERENCES:
1. Society of Automotive Engineers (SAE) Publications: Aerospace Material Specification (AMS) 1424 - "Aircraft Deicing/Anti-icing Fluid, Newtonian - SAE Type I".

2. AMS 1428 - "Aircraft Deicing/Anti-icing Fluid, Pseudo-Plastic, Non-Newtonian - SAE Type II".
3. Aerospace Recommended Practice (ARP) 4737 - "Aircraft Deicing Methods for Large Transport Aircraft"

END OF TOPIC

POINT OF CONTACT: Lt Ita Udo-Aka, (513) 255-3929, udoakaui@ml.wp

AF97-174 TITLE: Aero Propulsion and Power Technology

OBJECTIVE: Develop innovative approaches for turbine engines, advanced high speed propulsion systems, and electrical concepts.

DESCRIPTION: The Aero Propulsion and Power Directorate aggressively pursues major performance advances in all components of gas turbine engines under the Integrated High Performance Turbine Engine Technology (IHPTET) initiative. Technologies derived under this initiative have resulted in higher thrust-to-weight ratios and improved efficiencies. The focus of this topic is to consider those aspects in the design of gas turbine engines that impact affordability and robustness without compromising the performance advances required. Dual-mode ramjets and engine concepts using storable hydrocarbon fuels for sustained high speed flight are being developed. The emphasis is on supportable and affordable sustained high speed flight for military and commercial applications. The More Electric Aircraft initiative is focused on reducing the cost of force projection by doubling power system reliability and reducing dependence on aircraft ground support equipment. New analysis techniques, innovative designs and concepts for gas turbine engines, fuel and lubrication systems, high speed propulsion technology, and aircraft electrical power concepts are solicited.

PHASE I: Explore the feasibility of a new concept or concepts, through analysis and/or small scale testing to demonstrate the merits of the concept.

PHASE II: Provide detailed analytical derivations and prototypical device or hardware demonstrations.

POTENTIAL COMMERCIAL MARKET: The higher performance gas turbine engines and associated technologies will lead to more efficient, durable, and affordable commercial air breathing systems. Concepts developed under this program are suitable for integration into new engines for commercial use.

END OF TOPIC

POINT OF CONTACT: Richard J. Martin, (513) 255-2131, martinrj@wl

AF97-175 TITLE: Power Generation and Thermal Management

OBJECTIVE: Develop techniques, devices and components for aerospace power generation and thermal management/control.

DESCRIPTION: Electrical machines are needed that operate at high speeds (30-70 krpm), while transmitting power up to 300 kW. A machine running at higher speed can usually attain a higher power density and lower weight. However, a high power density motor or generator poses difficult technical challenges generally associated with the generation of high heat loads from magnetic and electrical losses and windage. Proposals are solicited which offer ways to either reduce these heat loads, or to ameliorate their effects. Examples of areas of interest include, but are not limited to high temperature windings and potting materials (>400 degrees C, 600 degrees C goal) for switched reluctance machines (SRMs), high temperature bearings for lubeless APU applications, fault tolerant winding configurations for permanent magnet (PM) generators, and high temperature PM materials with high performance. Other areas of interest are self-excitation for switched reluctance generators, hybrid bearings, touchdown (backup) bearings, and windage reduction.

Innovative thermal management concepts are also sought in the area of high temperature electronics and actuator cooling. An emerging family of silicon Carbide (SiC), Silicon Nitride (SiN), and Gallium Arsenide (GaAs) power electronics will operate at junction temperatures >200 degrees C in the near term and >600 degrees C far term. Even though the efficiencies of these devices will be much greater than conventional silicon devices, the power densities will be 4 to 8 times higher. Therefore, even greater power dissipation levels and waste heat fluxes must be dealt with. Passive thermal management concepts for high performance aircraft have the potential for being reliable and simplistic in design, and are therefore preferred. However, such concepts must deal with the inherent coupling of transient heat generation and transient acceleration-induced forces, and their effects on the cooling performance of the device. For example, as a direct result of aircraft orientation, altitude, and speed, efficient cooling of flight actuation components results in addressing a transient heat generation problem which is coupled to transient accelerations and transient external boundary conditions. When active cooling is proposed, existing aircraft fluids such as JP-8,polyalphaolefin, 7808, or 5606 must be used, unless that cooling system is conceived as a line replaceable unit (LRU) or is modular. Reduction of initial cost, maintenance, and logistics should be a key objective for all efforts. The effects of altitude or the impact of the use of compressor bleed air must be addressed when air cooling is proposed.

Areas of interest include but are not limited to, microchannel cooling, immersion cooling, heat exchangers with enhanced heat transfer surfaces, and the use of micro electro-mechanical systems (MEMS) to control and enhance interfacial heat transfer.

PHASE I: Develop a detailed technical definition of the problem, identify a proposed solution, and demonstrate the key technologies enabling the use of that solution.

PHASE II: Concentrate on development of prototype components, subsystem demonstrations, and hardware development.

POTENTIAL COMMERCIAL MARKET: These technologies have application for all high speed motors, generators, actuators, and power electronics which may be used in future high power density electric/hybrid transportation vehicles (commercial air, high-speed rail, and electric car), power generation, and manufacturing facilities.

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2. "High Temperature Generator Development," AFAPL-TR-74-69, Robert Fear, etal., Westinghouse Electric Corporation, AD-786 046.
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END OF TOPIC

POINT OF CONTACT: Phillip G. Colegrove, (513) 255-6241, colegrpg

AF97-176 TITLE: Advanced Capacitors for Power Electronic Systems

OBJECTIVE: Develop innovative wide temperature range (-55 to >300 degrees C), high reliability, dielectric materials and capacitors.

DESCRIPTION: Power electronics systems will be a pervasive technology in the next generation weapon systems. Typical power electronic systems include motor drives, inverter/converter for switched reluctance starter/generator systems, DC to AC inverters, and DC to DC converters. Common to all of these systems are capacitors, which are numerous and are critical in the operation of the system. Today's capacitors are the weakest link in power electronic system reliability and are limited in temperature capability to 125 degrees C. Application temperatures range from -55 to 200 degrees C and some applications may require >300 degree C operation with superior electrical performance. Candidate proposals shall address novel and innovative dielectric and/or high density packaging and/or manufacturing technologies to reduce cost. Specific uses include DC and AC power filtering, energy storage, and small signal applications for controls.

PHASE I: Demonstrate innovative capacitor approaches with substantial improvements in capacity, dielectric constant, voltage breakdown strength, dissipation factor, and temperature capabilities. Also, demonstrate advanced packaging and manufacturing technologies. Prototype laboratory capacitors should be fabricated and tested to demonstrate the feasibility of the technology.

PHASE II: Demonstrate development of a large-scale prototype capacitor components using innovative dielectric material or advanced high density packaging or manufacturing technology or a combination thereof. Actual application testing should be performed and electrical, thermal and life assessments made.

POTENTIAL COMMERCIAL MARKET: Capacitors are used in nearly every commercial and military system that consumes electrical power. Potential applications include all consumer electronics, medical electronics including defibrillators, automotive electronics including electric vehicles, and electric utilities. High temperature applications include aircraft engine ignition systems and electrical actuation, deep oil well instrumentation, and under the hood automotive applications.

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Powders," J. Am. Ceram, Soc., 1233-41 (1993).
3. Conway, B.E., "Transition from Super-Capacitor to Battery Behavior in Electrochemical Energy Storage," J. Electrchem, Soc., Vol 138, No.6, June 1991, pages 1539-1548.

END OF TOPIC

POINT OF CONTACT: David H. Fritts, (513) 255-6016,

AF97-177 TITLE: Advanced Battery Development

OBJECTIVE: Develop novel battery technology which demonstrates improvements over state-of-the-art performance.

DESCRIPTION: The Air Force has a need for high energy density, primary and secondary battery technology which can operate safely over a broad range of environmental conditions (temperature, shock, vibration, etc.) in cell sizes from 1 to 100 amp-hours. Battery designs capable of providing lightweight energy storage at voltages as high as 270 volts for aircraft use are of particular interest. The proposed technology shall include parametric studies of high rate discharge, rapid recharge, cycle life, float or overcharge behavior, safety and environmental.

PHASE I: Demonstrate advancement in the performance criteria cited in the description above.

PHASE II: Demonstrate the technology advancements in cells which are of a design that can be transitioned to a manufacturing capability at the contractor's facility or to a Phase III sponsor.

POTENTIAL COMMERCIAL MARKET: The dual use aspects of high energy density batteries finds application in a wide variety of consumer products. Batteries capable of powering items such as electric vehicles, power tools, laptops and cellular phones will benefit from advances in technology developed under this initiative.

REFERENCES:

1. A comprehensive overview of state-of-the-art battery technology can be found in "Handbook of Batteries, Second Edition," David Linden, Editor, 1995.

END OF TOPIC

POINT OF CONTACT: Steve Vukson, (513) 255-5461, vuksonsp@wl.wpaf

AF97-178 TITLE: Special Purpose Power and Power Components

OBJECTIVE: Develop efficient, high performance electric power systems, or components for airborne or ground applications.

DESCRIPTION: This solicitation seeks innovative proposals that address two basic power issues: power switching concepts based on wide bandgap semiconductor (WBG) devices, and power generation concepts based on advanced conversion technologies. These two areas address applications for the More Electric Aircraft program, solar-powered unmanned aerial vehicles (UAVs), power systems for ground support of UAV systems, air combat training and remote sensor sites.

The More Electric Aircraft program demands high-temperature (350 degrees C) and high-power electronics for use in power management and distribution, actuator motor control, on-site "smart" sensors, and data bus electronics. WBG semiconductor materials are projected to be excellent semiconductors for high power, high frequency and high temperature applications due to their high critical breakdown field, high saturation drift velocity, and high thermal conductivity. An objective of this solicitation is to seek proposals that offer solutions to critical issues related to WBG semiconductors, including, but not limited to (1) both deposited and natural dielectric insulators, (2) deposition and characterization of ohmic contacts, (3) cleaning techniques for WBG semiconductors, (4) ion implantation, doping, for WBG materials including diamond, and (5) concepts for WBG device topographies. Just as the evolution of silicon power semiconductor devices led to the development of advanced power concepts such as "smart" power and "optically-triggered" power, the evolution of WBG-based power semiconductor devices is expected to include implementation of these technologies, as well. This solicitation also seeks proposals containing innovative concepts that integrate such advanced technologies with the WBG-based devices.

There has been increased emphasis within DoD regarding commitmentto the use of UAVs. PV-powered UAVs offer a number of unique military operational advantages; they exhibit virtually nonexistent thermal signatures, their use of lightweight (nonmetallic) materials make them virtually radar transparent, their reliance on a noncombustible propulsion system enables operation at extremely high altitudes (60,000-100,000 ft), and their use of unlimited solar power together with energy storage enables very long duration missions. Such UAVs will require lightweight, high-power density PV arrays mounted on the aircraft wings to provide daylight power for electric-propulsion and charging of batteries for nocturnal propulsion. Power- and mass-density of photovoltaic (PV) cells

play an important role in enabling electrically-powered UAVs for a variety of military and civilian missions. Proposals are sought containing high performance PV cell concepts that approach or exceed performance parameters of 18% conversion efficiency, 0.04 lbs/ft*2, 1300 watts/kg.

Small, highly efficient power systems support a number of issues important to Air Force operations: the higher efficiency reduces the problem of fuel resupply in the field, improves mobility, reduces logistics costs for remote sites, and addresses environmental issues associated with operation of inefficient power systems in environmentally sensitive regions. Proposals submitted against this need should offer innovative concepts to transition advanced conversion technologies to use in mobile, and/or unattended power systems. Proposals may address an innovative solution to a subsystem (combustor, power conditioning, conversion system, etc) problem or a complete generator system. Desired features include a system efficiency greater than 10%; i.e. 4-5 times present thermoelectric generator systems; output power of 5 to 200 watts; operating temperature environment +100 degrees F to 135 degrees F; multifuel combustor using JP-4, propane, etc.

PHASE I: Demonstrate feasibility of the proposed system or component. Sufficient progress must be accomplished to make a low risk go/no go decision for a phase II contract. Proof-of-principle experiments are desirable.

PHASE II: Result in an operable prototypic component or system that is completely suitable for the intended application. A complete, standalone system is desirable; however, proposals that address only innovative improvements to existing component technologies such as highly efficient combustors, energy conversion devices, smart switching devices, improved high temperature switches are also welcome.

POTENTIAL COMMERCIAL MARKET: The benefits of smart power include improvements in device protection and power dissipation, and knowledge of device status by the controlling microprocessor. For small-scale electric power systems, present commercial and government systems are based on old conversion technology that is 3-5% efficient. Improving overall performance by implementing advanced conversion technologies dramatically reduces overall cost of operations. Some commercial uses of these power systems include air and marine navigation stations, gas metering stations, weather monitoring stations, off-shore platforms, communication relay stations, cathodic protection, and oil exploration. In addition to commercial applications, DoD uses for these types of power systems also include air training range communications, training range data relay stations, seismic observatories, remote monitoring stations, and intelligence gathering stations.

REFERENCES:

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3. T.R. Lamp, "Power System Assessment for the Burnt Mountain Seismic Observatory," Report No. WL-TR-94-2026, Wright Laboratory, WPAFB OH, March 1994.

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END OF TOPIC

POINT OF CONTACT: Thomas Lamp, (513) 255-6235, lamptr@wl.wpafb.a

AF97-179 TITLE: Advanced Power Technology Concepts

OBJECTIVE: Develop advanced power technology concepts in superconductivity, aircraft high voltage, and electromagnetic effects.

DESCRIPTION: Conduct exploratory development of advanced power technology concepts including superconductivity approaches, high voltage aircraft technologies, and electromagnetic effects solutions. Superconductivity approaches are to select and demonstrate superconducting materials and fabrication processes which offer the potential of superconductor operating capability at liquid nitrogen temperature, in magnetic fields greater than three tesla, and at current densities greater than 100,000 amps per square centimeter. High voltage aircraft technologies include innovative approaches for insulation system design, high electric field dielectrics and insulation aging characterization related to dedicated aircraft high voltage and high power systems. Electromagnetic effects solutions include the assessment of the survivability/vulnerability of More Electric Aircraft (MEA) circuits to both manmade and natural electromagnetic threats.

PHASE I: Tests of at least short samples of superconductors demonstrating the capabilities stated above. Characterization of dielectric needs and aging-related requirements for dedicated aircraft high voltage and high power components. Assess and select most applicable available computer codes which address electromagnetic effects on MEA circuits.

PHASE II: Demonstrate long lengths of superconductors for use in coils, generators, and motors and assess the use of cryocoolers for airborne applications. Develop electrical insulation design criteria and aging-mitigation techniques for dedicated aircraft high voltage and high power systems. Produce a computer code which specifically addresses electromagnetic effects on MEA type aircraft.

POTENTIAL COMMERCIAL MARKET: High temperature superconductors will be used in commercial energy storage applications to manage peak power in utility grids, ground power generators, and electric motors. High voltage insulation technologies are used in both commercial aircraft power systems and utility ground power components. Electromagnetic survivability/vulnerability information is directly related to commercial aircraft.

REFERENCES:
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END OF TOPIC

POINT OF CONTACT: Jerrell M. Turner, (513) 255-5179, turnerjm@wl

AF97-180 TITLE: High Mach, Advanced Air-Breathing, Storable-Fueled Engine Technology

OBJECTIVE: Develop key technologies for advanced cycle engines operating from Mach 0 to 8.

DESCRIPTION: Engines of interest in the Mach 0 to 8 flight regime include combined cycle systems (such as turboramjets (TurboRJ) and air-turborockets (ATR)), pulse detonation engines (PDE) and other advanced concepts. The turbomachinery aspects of cycles such as the TurboRJs and ATR, while flexible, efficient and of great importance in the Mach 0 to 4 range, are not of interest under this topic. Technologies pertinent to the simplicity, low weight, low cost, and high specific impulse of the ramjet in the Mach 3 to 6 flight range and the scramjet from Mach 6 to 8 are of great interest. The PDE, another cycle of interest, combines the simplicity and efficiency of detonation wave combustion with the capability of air breathing at flight speeds of Mach 0 to 4 and ramjet or rocket operation above Mach 4. Technologies of interest directly involve the air, fuel, and/or combustion flow path, and use noncryogenic fuel. These include total engine concepts, the air intake systems; exit nozzles; solutions to reduce drag and total pressure losses; innovative fuel ignition, piloting and flameholding methods; solutions to reduce the length, weight, and/or cost of the inlet, combustor and nozzle and components; ramburner structures and materials, endothermic fuel reactor/engine issues; ramburner cooling techniques. Proof-of-concept testing is preferred, but analytical investigations will be considered at the Phase I level.

PHASE I: Identify novel concepts and quantify their payoff when integrated into the selected high Mach propulsion system, and to conduct small-scale experiments to demonstrate concept feasibility. If a strictly analytical approach is proposed, sufficient analysis must be performed to demonstrate a high degree of concept feasibility and a plan for experimental direction in Phase II must be shown.

PHASE II: Large scale development and testing which would include identification of appropriate facilities, and pertinent capabilities.

POTENTIAL COMMERCIAL MARKET: High Mach, advanced airbreathing, storable-fueled engines have potential application to a multitude of vehicles which require efficient acceleration and cruise capabilities. Military application might include long-range, high speed aircraft for reconnaissance and strike missions, stand-off missiles, and drones. Commercial applications might include high-speed civil transport or passenger aircraft. Dual use applications include military/commercial space launch vehicles which require an airbreathing propulsion system for the initial atmospheric

boost phase. The PEGASUS launch vehicle and similar systems could benefit from the use of airbreathing boost propulsion.

REFERENCES:
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END OF TOPIC

POINT OF CONTACT: Beverly R. Chaffin, (513) 255-2175, chaffibr@w

AF97-181 TITLE: Accelerated Convergence Rate for Numerical Analysis of Ramjets and Scramjets

OBJECTIVE: Develop techniques to accelerate the convergence rate of a numerical code for time-asymptotic ramjet/scramjet flows.

DESCRIPTION: The available computational fluid dynamic (CFD) codes require enormous amounts of computer processing unit (CPU) time to solve steady-state flow problems. Most CFD codes are designed to solve the Navier Stokes equations in a time-marching fashion. This is a reliable technique, but it can be quite expensive in terms of CPU time, especially when one is interested only in the steady-state solution. Added complexity arises due to the reacting flows encountered in ramjet/scramjet analysis.

Applications of unfactored implicit relaxation techniques hold the promise for accelerating the convergence of time-asymptotic calculations. Also, alternate equation sets such as the Reduced Navier-Stokes procedure could be implemented in a space-marching fashion, either as an alternate solution procedure or to provide an improved initial condition for a traditional time-marching procedure. Other novel ideas for faster relaxation schemes are also applicable.

Application of a new solution technique into an existing code presents challenges such as accuracy, stability, and optimization. The developer must ensure that the new technique adequately represents the flow physics. It is also necessary for the new technique to be robust, such that it is stable as it approaches the steady-state solution. The techniques must also be optimized to provide the largest possible savings in CPU time.

PHASE I: A scheme to accelerate the convergence for time-asymptotic solutions will be implemented into a CFD code with multi-block or hybrid grid capabilities. The validity of the concept will be demonstrated and the scheme will be tested for model problems involving streamwise reversed flows, strong streamwise uptstream influence, and supersonic and subsonic flow. Results will be compared to a traditional time-marching solution in terms of accuracy and CPU time.

PHASE II: Extend the acceleration scheme for chemically-reacting flows, including hydrocarbon chemistry.

POTENTIAL COMMERCIAL MARKET: The CFD tool developed will have many applications in industry. The tool is expected to have uses in automotive and other industrial applications, in addition to the military and commercial aircraft industry.

REFERENCES:
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2. Thompson, D.S. and Anderson, D.A., "A Pseudo-Unsteady Approach for Predicting Steady Supersonic Flows," AIAA Paper 87-0541.
3. Edwards, Jack R. and McRae, D. Scott, "An Efficient Nonlinear Relaxation Technique for the Three-Dimensional, Reynolds-Averaged Navier-Stokes Equations," AIAA Paper 93-0540.
4. Rubin, Stanley G. and Tannehill, John C., "Parabolized/Reduced Navier-Stokes Computational Techniques," Annual Review of Fluid Mechanics, 1992, pp 117-144.

END OF TOPIC

POINT OF CONTACT: Mark Hagenmaiaer, (513) 255-5210, hagenma@poss

AF97-182 TITLE: Advanced Instrumentation for Ramjet/Scramjet Combustors

OBJECTIVE: Develop advanced high resolution, high frequency instrumentation for use in subsonic and supersonic combusting flows.

DESCRIPTION: Obtaining accurate measurements of various flow parameters in a combusting flowfield without disturbing the flow is a difficult task. Various optical "flow" diagnostics techniques are currently under development with the eventual goal of being used in the harsh environments of direct connect and free jet facilities. The need still exists for the development of new techniques and/or refinement of the currently available techniques to allow accurate point or field measurements of velocity, temperature, density, fuel concentration, and the constituency of the exhaust effluence in hydrocarbon and hydrogen fueled ramjet and scramjet propulsion systems. Time resolved and time averaged measurements are required to allow validation of analytical/computational codes.

New robust miniature instrumentation is required to assess the performance potential of subsonic and supersonic ramjet combustors and various flow path components in free jet and direct connect facilities. In particular, the development of micro-scale high frequency sensors for measurements of wall pressure, temperature, skin friction and heat flux capable of surviving high enthalpy (up to Mach 8) flight conditions is desirable. Single- and multi-element addressable micro-opto-mechanical sensors are required for engine health monitoring and flow control. These sensors shall require minimal pre- and post-test calibration.

PHASE I: Develop and refine the measurement technique and/or the instrumentation concept to allow proof-of-concept demonstration in representative subsonic and supersonic research flows with and without chemical reaction and heat release.

PHASE II: Develop the instrumentation and the associated measurement technique to a point where it could be employed and used in realistic combustor temperature and pressure environment of direct connect and free jet facilities.

POTENTIAL COMMERCIAL MARKET: Potential for dual use is great. Similar if not identical instrumentation and measurement techniques are required in automotive, ground power generation, and incineration, and the aerospace industries. Commercial success is however, dependent on sensor/instrument durability, practicality, accuracy, and cost. The intensive technology requirements and the relatively long system development time period forces the small businesses to look to the government agencies and the national laboratories for partnership and

investment. There is, however, a great market in the US and abroad for commercialization of micro sensors and optical instruments.

REFERENCES:

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END OF TOPIC

POINT OF CONTACT: Abdollah Nejad, (513) 255-1234, nejadas@possum

AF97-183 TITLE: Novel Sources of Electromagnetic Radiation for Advanced Combustion Diagnostics

OBJECTIVE: Develop and demonstrate electromagnetic radiation sources tailored for measuring key combustion parameters.

DESCRIPTION: A principal driving force in the continuing development of advanced gas-turbine combustors is the reduction of environmentally hazardous emissions. Emerging gas-turbine design methodologies increasingly seek to achieve this low-emissions goal through the use of computational fluid dynamics and chemistry (CFDC) codes. The successful performance of these codes is predicated upon experimental validation through measurement of key combustion parameters. Advanced, nonintrusive, laser-based diagnostics represent an ideal approach to achieving this validation. Unfortunately, the characteristics of existing laser sources often limit the application of these powerful diagnostics techniques. This topic seeks the development and demonstration of novel electromagnetic radiation sources with unique performance advantages over existing sources. Advantages might include, but are not limited to, extended spectral coverage, tailored bandwidth, increased power, decreased noise, and enhanced temporal characteristics.

PHASE I: Demonstrate experimentally the potential for a proposed source to provide improved measurement of key combustion parameters compared to existing state-of-the-art sources. Modeling and other computational support of the concept is advantageous but not sufficient for a Phase I effort. Simply proposing a novel source of electromagnetic radiation is also insufficient; the potential advantages the proposed source brings to combustion diagnostics applications must be thoroughly explored.

PHASE II: Provide complete demonstration and documentation of the performance gains associated with the novel source of electromagnetic radiation. Ideally, this demonstration would be achieved in conjunction with a combustion application of interest to the Air Force.

POTENTIAL COMMERCIAL MARKET: The gas-turbine design methodologies validated through the use of advanced, laser-based diagnostics designed around these novel sources will have tremendous impact on the future of both military and commercial aviation, particularly as these techniques contribute to the reduction of emissions. The sources themselves have tremendous dual use commercialization potential as well. The market for this equipment includes many university, government, and industrial researchers who require tailored sources to make measurements under extreme conditions.

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2. R.A. Cheville and D. Grischkowsky, "Far-Infrared TeraHertz Time-Domain Spectroscopy of Flames," Opt. Lett.20, 1646-1648 (1995).

END OF TOPIC

POINT OF CONTACT: James R. Gord, (513) 255-7431, gordjr@wl.wpafb

AF97-184 TITLE: Self Contained Dampers for Gas Turbine Engines

OBJECTIVE: Develop a self contained damper for use in an expendable gas turbine engine.

DESCRIPTION: Self contained dampers are required to replace conventional liquid squeeze film dampers in future expendable gas turbine engines. In addition to the properties normally associated with a damper, the dampers developed under this effort should demonstrated the following properties: temperature capability to 1500 degrees F, low cost, low volume, and low weight. The Phase I effort shall produce a system design in coordination with a gas turbine engine manufacturer participating in the Joint Expendable Turbine Engine Concept (JETEC) program. As a minimum, the design shall include analytical predictions of stiffness, damping coefficient, critical speed, and unbalance response applied to a JETEC rotor. The Phase II effort shall result in the fabrication and testing of hardware sized for a JETEC demonstrator engine. The hardware shall be tested at conditions projected for a JETEC demonstrator engine.

PHASE I: Design a self-contained damper system for application in future expendable gas turbine engines.

PHASE II: Successfully demonstrate a self-contained damper system at operating conditions projected for future expendable gas turbine engines.

POTENTIAL COMMERCIAL MARKET: This technology has application in any system where rotor damping is desired without the use of liquid squeeze film dampers. Specific applications where this may be desirable include automobile turbochargers, high speed electric motors, and dental drills.

REFERENCES:
1. Rio, R.A., "Turbine Rotordynamic Evaluation," Vol I, AFAPL-ATR-76-81 (1978).

END OF TOPIC

POINT OF CONTACT: Nelson H. Forster, (513) 255-4347, forstenh@wl

AF97-185 TITLE: Thermally Stable Jet Fuels, Additives, and Test Methods

OBJECTIVE: Develop high heat sink thermally stable jet fuels, additives, improved test methods and improved fuel system components.

DESCRIPTION: Jet fuel is used to cool many aircraft and engine subsystems on current and future aircraft. Subjecting the fuel to high temperatures for long periods of time causes the fuel to degrade and form gums, varnishes and coke that can plug engine fuel nozzles, afterburner sprayrings/spraybars, fuel manifolds and fuel controls. Fuel additives can be used to improve many characteristics of the fuel. For example additives can reduce fuel degradation, prohibit the formation of frozen water particles, improve lubricity, reduce static discharge and improve low temperature flow properties. Advanced engines require fuels that will be used at supercritical conditions or that will undergo endothermic reactions to provide cooling to various engine components. The objective of this topic is to solicit technologies that improve fuel characteristics (i.e.increase thermal stability, improve low temperature flow behavior, inhibit free water from freezing etc.), to improve the design of aircraft and engine fuel system components, and reduce fuel system maintenance. Also of interest are new fuel additives, test methods (both laboratory and field), advanced models and computational chemistry techniques to predict fuel properties and the environmental aspects of fuel, fundamental methods to study fuel freezing, water in fuel freezing, fuelthermal degradation (both autoxidation and pyrolysis), fundamental aspects of the supercritical behavior of fuels, and technologies related to the use of endothermic fuels. Technologies submitted under this topic can be for conventional fuels (i.e. J-8, JP-8+100, JP-5, Jet A or Jet A-1), supercritical fuels (JP-900) or endothermic fuels.

PHASE I: Demonstrate the feasibility of the technology and quantify the payoffs for both military and commercial applications.

PHASE II: Demonstrate the application of the technology, demonstrate a prototype of the technology, validate performance, and quantify payoffs for both military and commercial applications.

POTENTIAL COMMERCIAL MARKET: All technologies developed under this topic have both military and commercial jet fuel applications due to the similarities of the jet fuels (i.e. JP-8 is commercial Jet A-1 fuel with a military additive package).

REFERENCES:
1. "JP-8+100: The Development of High Thermal Stability Jet

Fuel," S.P. Heneghen, S. Zabarnick, D.R. Ballal, and W.E. Harrison, AIAA Paper 96-0403, 34th Aerospace Sciences Meeting, January 1996.

2. "Deposition for High Temperature Jet Fuels," T. Edwards and J.V. Atria, ACS Division of Petroleum Chemistry Preprints, Vol 40, No. 4, pp. 649-654, August 1995.

END OF TOPIC

POINT OF CONTACT: William Harrison, (513) 255-6601, harriswe@wl.

AF97-186 TITLE: Advanced Techniques for Ultra Trace Analysis of Aviation Fuel

OBJECTIVE: Develop and demonstrate techniques for quantitating ultra-trace-level contaminants in aviation fuel.

DESCRIPTION: Many aircraft performance improvements are accompanied by substantial heat loads that lead to increased thermal stress on the fuel-the primary coolant for on-board heat sources. The result is increasingly complex thermal management, which affects aircraft design and maintenance requirements. Continuing Air Force research has revealed the critical role that trace quantities of contaminants can play in the chemistry that limits fuel thermal stability. Unfortunately, reliable techniques for quantitating the concentration of ultra-trace-level contaminants in aviation fuel are largely unavailable. The plethora of compounds present in typical aviation fuels complicates efforts to make these important measurements. This topic seeks the development and demonstration of new analytical techniques for quantitating key contaminants, such as water, Cu, Fe, Cn, Pb, S, N, and P, in the problematic fuel matrix. Requirements of a successful technique include extreme sensitivity and selectivity. The measurements achieved through proposed methodologies will drive the continued development of chemical kinetics models essential to designing next-generation aviation fuels.

PHASE I: Demonstrate experimentally the potential for a proposed technique to provide improved measurement of ultra-trace-level contaminants compared to exiting state-of-the-art methodologies.

PHASE II: Provide complete demonstration and documentation of the performance gains associated with the proposed technique. Ideally, this demonstration would be achieved in conjunction with a fuel application of interest to the Air Force.

POTENTIAL COMMERCIAL MARKET: Successful commercialization of the proposed techniques will accelerate the development of advanced fuels and yield benefits in terms of increased performance and reduced environmental impact for both military and commercial aviation. The quantitation methodologies have tremendous dual use commercialization potential as well. Ultra-trace-level quantitation is central to research and development underway in many university, government, and industrial facilities. Applications span a vast array of disciplines including materials and biomedical research.

REFERENCES:

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92-2112, DTIC Accession Number AD-A260249.
2. S.P. Heneghan, S. Zabarnick, D.R. Ballal, and W.E. Harrison, "JP-8+100: The Development of High Thermal Stability Jet Fuel," AIAA Paper No. 96-0403, Presented at the AIAA 34th Aerospace Sciences Meeting and Exhibit, January 1996, Reno NV.

END OF TOPIC

POINT OF CONTACT: W. Melvyn Roquemore, (513) 255-6813, roquemwm@

AF97-187 TITLE: Aircraft Turbine Component Technology - Aerodynamics and Cooling

OBJECTIVE: Develop concepts for improving aerodynamic performance and reducing cooling flow requirements of turbine components.

DESCRIPTION: Proposals should address the development of aircraft engine turbine component technologies in the area of aerodynamics and heat transfer. A major trend in turbine components for aircraft engines is increased loading, increased turbine inlet temperature and reduced cooling air. New design concepts, analysis techniques, experimental test methods and high temperature instrumentation development are needed to further the technology in these areas. Proposals should focus on an effort that contributes to meeting the goals of the Integrated High Performance Turbine Engine Technology (IHPTET) program.

PHASE I: Explore the feasibility of a new concept or concepts, through analysis or small scale testing, to demonstrate the potential merits of the concept.

PHASE II: Provide detailed analytical derivations, prototype and/or hardware.

POTENTIAL COMMERCIAL MARKET: Higher performance turbine engines and associated technologies will lead to more efficient, quieter and environmentally acceptable propulsion systems. Turbine technology improvements play a major role in military applications and there is great potential to transition to commercial use.

REFERENCES:
1. "Progress Towards Understanding and PRedicting Convection Heat Transfer in the Turbine Gas Path," Robert J. Simoneau and Frederick F. Simon, International Symposium on Heat Transfer in Turbomachinery, Athens, Greece, August 1992.

END OF TOPIC

POINT OF CONTACT: Charles MacArthur, (513) 255-6768, macartcd@wl

AF97-188 TITLE: Compression System Design Methodology

OBJECTIVE: Develop concepts or software to advance aerodynamic and mechanical technology of compression systems and secondary gas path systems.

DESCRIPTION: A major trend in compression system hardware is the increased utilization of highly loaded, low aspect ratio, complex shape airfoils in multistage configurations. Increased loading produces larger blade wakes resulting in significant unsteady aerodynamic and aeromechanical interactions between stages. In addition, increased loading has produced stall margin and efficiency sensitivity to blade tip clearance levels. Airfoils shapes tailored to meet specific loading, efficiency, and operability goals produce significant mechanical design challenges. Aerodynamic and aeromechanical design capability does not fully account for the unsteady interactions, the effects of complex airfoil shapes, or the sensitivity to tip clearances that exist in compression systems. Developments that improve the understanding of these phenomena, such as advanced measurement methods and new design models, are desired. Innovative concepts that exploit an understanding of these phenomena are also desired. Areas of prime technical importance include endwall and secondary flows, time unsteadiness, forced response and mistuning, and innovative diagnostic instrumentation.

Obtaining precise secondary gas path flow control will play an increasingly larger role in optimizing engine efficiency, as further gains in the major engine components become more difficult to achieve. Understanding primary and secondary gas path interactions can be critical to the performance of both. Reducing parasitic leakage and seal deterioration, while minimizing air needed for cooling, ventilation, and thrust balancing, is a significant challenge as the secondary gas path environment becomes more extreme. Innovative concepts and models leading towards precise secondary gas path flow control are desired. Areas of particular interest include film riding seals, trenching and shrouds, innovative thrust balancing, counter rotation, and disk pumping.

PHASE I: Demonstrations of concepts or software for the development of advanced compression system or secondary flow system design.

PHASE II: Bench tested technology concepts or software for advanced compression system or secondary flow system design, adequately documented to be acceptable to the technical community.

POTENTIAL COMMERCIAL MARKET: The improvements gained in compression and secondary gas path system performance and efficiency are directly applicable to both military and

commercial gas turbine engines.

REFERENCES:

1. Bullock, R., and Johnson, I., Aerodynamic Design of Axial-Flow Compressors, "Chapter III - Compressor Design System," NASA SP-36, 1965.
2. Puterbaugh, S.L., and Brendel, M., "Tip Clearance Flow-Shock Interaction in a Transonic Compressor Rotor," AIAA95-2459.
3. "Unsteady Aerodynamic Phenomena in Turbomachines," AGARD-CP-468, August 1989.
4. "Loss Mechanisms and Unsteady Flows in Turbomachines," AGARD-CP-571, January 1996.
5. Smith, L.H., "Wake Ingestion Propulsion Benefit," Journal of Propulsion and Power, Vol. 9., No. 1, Jan-Feb 1993.
6. Moore, A., "Gas Turbine Engine Internal Air Systems - A Review of the Requirements and the Problems," ASME Paper 75-WA/FT-1, November, 1975.
7. Mayhew, E.R., Bill, R.C., Voorhees, W.J., O'Donnell, J., "Military Engine Seal Development: Potential for Dual Use," AIAA 94-2699.
8. Steinetz, B.M., and Hendricks, R.C., "Engine Seal Technology Requirements to Meet NASA's Advanced Subsonic Technology Program Goals," AIAA 94-2698.

END OF TOPIC

POINT OF CONTACT: Ellen Mayhew, (513) 255-8210, mayhewer@wl.wpaf

AF97-189 TITLE: <u>Real-Time Ontogenetic Engine Health Monitoring (EHM) of Gas Turbine Engines</u>

OBJECTIVE: Develop a real time ontogenetic (RTO) EHM system and demonstrate its capabilities using real or simulated engine sensed or derived data.

DESCRIPTION: The ability to trend an engine's performance has been possible ever since James Watt fired up his first steam engine; however, the development of the ability to monitor and predict an engines life, health and performance has not kept in step with technological advances. The introduction of digital engine control management and the use of electrical data buses enables us to obtain considerable sensed data while the engine is running; however, we have never capitalized on this and have only managed historical trending of vibration, temperature and rotational speeds. By using neural networks, NASA has produced a credible real time engine health monitoring system for their reusable rocket engines. With major advances in computer science and production control technologies, we can now realize a true EHM system that will trend the performance, life consumption and health in real time. The introduction of an ontogenetic EHM system will considerably reduce engine life cycle costs and enhance operational capabilities.

PHASE I: Develop an ontogenetic EHM system that can provide real-time monitoring of creep and fatigue life, component condition and life consumption, engine performance and engine health based on actual or simulated engine sensed or derived data. The system will accept performance algorithms and historical information to produce its own expert system; it will then show the capability to monitor, trend, predict and inform the required monitors, while developing its own ontogenetic knowledge/experience.

PHASE II: Develop the EHM system to fly on a USAF aircraft and provide a true intelligent EHM system that will relate engine condition information in a user friendly form related to Technical Orders. The system will demonstrate a system redundancy capability, in that it will use tools such as probabilities techniques, based on data from the active sensors, to compensate for any system fault.

POTENTIAL COMMERCIAL MARKET: The development of a RTO EHM system will bring major cost reductions to the civilian aerospace community. Never intended to replace the technician, RTO EHM will provide fast and accurate diagnostic information to reduce maintenance times, no-fault founds and turn-around times. The improved critical life management aspect will reduce the engines cost of ownership.

REFERENCES:

1. T. Trode and W. Merrill, "A Real Time Net Estimator of

Fatigue Life," NASA Report # TM-103117 for The International Joint Conference on Neural Networks, cosponsored by IEEE and INNS, San Diego CA, 17-21 June 1990.

END OF TOPIC

POINT OF CONTACT: Andrew J. Green, (513) 255-2734, greenaj@wl.wp

AF97-190 TITLE: Combustor Acoustics Modeling Technology Research

OBJECTIVE: Develop methods to identify the physical causes of acoustic instability in high performance aircraft gas turbine engine combustors.

DESCRIPTION: Future gas turbine engine combustors will be physically shorter, operate at higher through flows and axial flow velocities, burn liquid and gaseous fuel streams and operate with a lower pressure drop. Occasional breakdown of the combustion flow causes extreme pressure and temperature pulsations inducing low and high cycle fatigue in hot section components. Current combustor design systems lack the capability of identifying acoustic coupling of these combustion processes.

PHASE I: Phase I will require an in depth analysis to identify the casual physics of combustion driven acoustic resonances in gas turbine combustor environments.

PHASE II: Focused towards proposed methods to eliminate resonances. These methods shall be consistent with the practical features and environmental limitations of gas turbine combustors. The information gained under phase I will be used to design and fabricate a subscale test article which exhibits the anticipated conditions in a modern gas turbine engine. A test plan shall be prepared identifying the testing and development work required to validate the physics and suppression concepts identified. Testing shall demonstrate both the resonant states of the test article and the effectiveness of the proposed suppression and avoidance systems.

POTENTIAL COMMERCIAL MARKET: All commercial gas turbine engines require combustion systems. Characterization of the impact of unsteady combustion processes on high and low cycle fatigue will provide great benefits in extending hot section life and performance, therefore, directly benefiting commercial gas turbine engines.

REFERENCES:
1. Sterling, James David, "Longitudinal Mode Combustion Instabilities in Air Breathing Engines," California Institute of Technology, Volume 48/06-B. of Dissertation Abstracts International, Page 1746

END OF TOPIC

POINT OF CONTACT: Carlos A. Arana, (513) 255-5974, aranacaa@wl.w

AF97-191 TITLE: <u>Adaptive Filtering for Improved Turbine Engine Performance and Component Estimation</u>

OBJECTIVE: Develop new adaptive filtering methodologies with capability to optimize over a large number of engine parameters.

DESCRIPTION: Modern gas turbine engines are controlled by digital electronic engine controls. They employ conventional linear control system algorithms which are implemented with discrete time realizations. The most advanced engine control systems now employ model based control techniques which provide more accurate control, optimizing dynamic performance over the engines operating envelope. Model based controls employ a tracking filter to adjust the engine model. Future engine control systems will have higher performance, lower cost, employ damage tolerance techniques, and have significantly reduced maintenance cost. They will require active combustion and stall margin control. These goals are only realizable by employing adaptive filtering, or tracking filters around each subsystem; i.e., sensors, components, and active engine performance loops. The complexity and cost of implementing many individual tracking filters prevent general use of this approach. The development of improved tracking filter methodologies which have the capability to optimize a variety of important engine subsystems will result in a substantial improvement in engine control. Investigation of generalized techniques such as linear adaptive control, and nonlinear sliding mode control are appropriate. Implementation of these new techniques will enable the integration and cost effective implementation of engine performance trending, deterioration estimation, fault isolation, and dynamic control.

PHASE I: Develop conceptual designs for an advanced tracking filter which will estimate a significant number of key engine parameters. The design should apply advanced system identification techniques to the turbine engine system with its associated sensor suite.

PHASE II: Demonstrate the effectiveness of a multiple parameter optimization (tracking) filter over state-of-the-art techniques. In this effort, a tracking filter algorithm which implements the most promising technique developed in the Phase I effort will be designed and tested. An appropriate engine model will be employed in the design and test of the advanced tracking filter.

POTENTIAL COMMERCIAL MARKET: Commercial aircraft engines will realize significant benefits in terms of reduced operating cost by improvements in control efficiency and better predictive diagnostics. Fuel and maintenance costs will go down. The technology can also significantly improve the control of industrial robotic manipulators and advanced electric motors. It will especially benefit systems with large uncertain

dynamics.

REFERENCES:

1. "Preliminary Flight Evaluation of an Engine Performance Optimization Algorithm," H.H. Lambert, G.B. Gilyard, AIAA Joint Propulsion Conference, June 24-26, 1991, Sacramento CA, Paper #AIAA-91-1998.

2. "Estimating In-Flight Engine Performance Variations Using Kalman Filter Concepts," G.W. Gallops, AIAA Joint Propulsion Conference, July 10-12,1989, Monterey CA, Paper #AIAA-89-2584.

3. "Performance Seeking Control for Cruise Optimization in Fighter Aircraft," Eric J. Tich, Peter D. Shaw, AIAA Joint Propulsion Conference, June 29 - July 2, 1987, San Diego CA, Paper #AIAA-87-1929.

END OF TOPIC

POINT OF CONTACT: Kenneth Semega, (513) 255-6690, semegakj@wl.wp

AF97-192 TITLE: <u>Whole Wafer Thermal Measurement</u>

OBJECTIVE: Develop an affordable thermal measurement technique for reliably measuring in-situ temperature uniformity across semiconductor wafers.

DESCRIPTION: The production of <0.5 mm VLSI silicon integrated circuits and III-IV semiconductor heterojunction and quantum well devices requires the capability to measure and control the across-wafer temperature to ±1°C at temperatures ranging from 150°C to 1100°C depending on the type of fabrication processes used. Currently either thermocouples or optical pyrometers are used for measuring the wafer temperature. Thermocouples in contact with the wafer provide the actual temperature of the wafer only in the region of the contact point. While fairly reliable, thermocouples suffer from slow response time, and their lifetime is inversely proportional to the process temperature. Optical pyrometers, on the other hand, respond rapidly, but the measured temperature can be unduly influenced by variations in the wafer emissivity which is a function of the number and type of layers on the wafer. In addition, the reliability of pyrometers is of concern. For the most part, these techniques are also restricted to measuring the temperature at a point or small region of the wafer.

PHASE I: Develop and demonstrate the feasibility of concepts for measuring in real-time the temperature across a semiconductor wafer to an accuracy of ±1°C at temperatures appropriate for the semiconductor device targeted for the in situ environment. Concepts must be compatible for single-wafer and/or batch processing and have a benign effect on the processing environment.

PHASE II: Fabricate a breadboard demonstration of the concepts defined in Phase I and experimentally demonstrate the approach for in situ, real-time measurement capability, Plans shall be developed to bring the concept to a commercially viable product for use as an in situ, real-time technique for measuring and controlling the across-wafer temperature in a semiconductor production process.

POTENTIAL COMMERCIAL MARKET: An accurate and reliable in situ whole-wafer temperature measurement technique will have an immediate commercial market in temperature monitoring and control for a wide variety of thermal processing technologies such as rapid thermal processing, molecular beam epitaxy and metallo-organic chemical vapor deposition.

REFERENCES:
1. W.F. Kosonocky, et al., "Multi-Wavelength Imaging Pyrometer (M-WIP) for Semiconductor Process Monitoring and Control," WL-TR-95-8010, 1995.

END OF TOPIC

POINT OF CONTACT: Dr. Charles Strecker, (513) 255-2644, streckcl

AF97-193 TITLE: Systems Engineering Using Key Characteristics

OBJECTIVE: Develop an integratable software tool to manage the systems engineering process using Key Characteristics.

DESCRIPTION: Key Characteristics (KCs) can be defined as product features, manufacturing process parameters, and assembly process issues that significantly affect product performance, function, and form. They are classified into three different types of engineering functions: 1) Product Key Characteristics (PKCs), which are product geometric features and material properties that have a significant impact on the product performance, function and form at each product assembly level, 2) Assembly Process Key Characteristics (AKCs), which are the features during each assembly stage on the product, tool, fixture, or procedures that significantly affect the assembly process, and 3) Manufacturing Process Key Characteristics (MKCs), which are the manufacturing machine process parameters and/or work piece fixturing features for machine tools and equipment that significantly affect the realization of a product. Key Characteristics when used in conjunction with the development of the Work Breakdown Structures (WBS) and the project planning processes could provide a vehicle to 1) significantly reduce the learning curve associated with the start of assembly by identifying the critical issues early in the product development cycle, and 2) assess manufacturing cost trade-offs during product development by considering engineering issues, manufacturing process capability, assembly issues, and customer requirements. By identifying the critical product features upfront, resources can be allocated to address them through multi disciplinary teams.

PHASE I: Phase I of this effort will consist of a detailed analysis of the appropriate processes and tools that need to interact to provide the maximum utility for the systems engineering managers. Phase I will culminate with the development of an initial concept feasibility demonstration on a tool to help create, manage, and communicate Key Characteristics throughout the life cycle of the product development process.

PHASE II: Phase II will focus on the continued development, refinement, demonstration and implementation of the tool. This phase will culminate with the release of at least a beta version software tool.

POTENTIAL COMMERCIAL MARKET: Any company that designs complex mechanical systems. Boeing, Northrop Grumman, Ford, and General Motors are using the notion of Key Characteristics. However, instead of using software tools to manage them, they have a thick book that is hard to track, update, and distribute.

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3. Cunningham, Timothy, et al., "Definition, Analysis, and Planning of a Flexible Assembly Process," 1996 Japan-USA Symposium on Flexible Automation Conference Proceedings, Boston, MA, July 7-10, 1996.

END OF TOPIC

POINT OF CONTACT: George B. Orzel, (513) 255-7371, orzelgb@ml.wp

AF97-194 TITLE: New Methods for Copper Electro-Plating Advanced Printed Wiring Boards

OBJECTIVE: Develop novel plating technologies that decrease environmental impact of producing electro-deposited copper foils.

DESCRIPTION: Department of Defense and commercial suppliers of printed wiring boards require new methods of depositing copper foils which are easily controlled, cost-effective, and environmentally benign. The packaging and interconnection of advanced electronics systems is presently achieved through laminate-based printed wiring boards. This technology is founded in the electrical and mechanical performance gained through the use of electro-deposited copper foils. Electro-deposited copper contained in laminated boards provides the necessary surface and through-hole connections for conductivity. Additive-based chemistries currently in use in electro-plating baths are difficult to control and shorten the life of the plating bath. Additionally, manufacturing processes have not progressed sufficiently to support the level of performance required in advanced printed wiring boards. Novel, more environmentally friendly, plating technology is needed which can achieve the control necessary for increased performance and reliability of newer, fine-featured designs.

PHASE I: Phase I will demonstrate the feasibility of an environmentally friendly, plating technology for depositing copper foils as described above.

PHASE II: The goal of Phase II will be to fabricate a complete prototype plating system using the technology demonstrated in Phase I. Advanced design printed wiring boards with fine-features will be plated and their electrical and mechanical properties shall be measured to demonstrate the performance improvements.

POTENTIAL COMMERCIAL MARKET: Copper plating is the basis of printed wiring board manufacturing for both military and commercial suppliers. These plated boards are the foundation of a world-wide market of $18 billion in commercial electronics. New methods for improved plating can be more reliable, more cost-effective, and provide high technology boards at lower environmental impact.

END OF TOPIC

POINT OF CONTACT: Troy Strouth, (513) 255-2461, strouttl@ml.wpaf

AF97-195 TITLE: Manufacturing Information for Electronics System Upgrades

OBJECTIVE: Develop methods and techniques to automate the creation of manufacturing information and simulation models for emerging and legacy electronics systems

DESCRIPTION: Current state-of-the-art methodologies and techniques for creating manufacturing information and simulation models needed to drive the reengineering of "bad actor" electronics or to perform electronics systems upgrades are based upon manual and error prone approaches. In many cases, the design data representing the physical implementations is inaccurate and/or incomplete. The purpose of this effort is to explore and exploit emerging VHDL (VHSIC Hardware Description Language) and VHDL-A (AHSIC Hardware Description Language - Analog) modeling practices and approaches. In addition, new principles and practices must be developed for automating the extraction of information needed to drive simulation model creation from legacy engineering and manufacturing information. Examples of legacy engineering and manufacturing information sources are test program sets, schematics, performance specifications and netlists.

PHASE I: Phase I will develop methodologies and techniques for a highly automated process to extract the salient information necessary to create accurate manufacturing information and simulation models for emerging or legacy electronics systems. In addition, software tools needed to automate the process and ensure its repeatability will be identified for development in Phase II. The feasibility of the developed process will be demonstrated at the end of the Phase I effort.

PHASE II: Phase II would develop the software tools to automate the extraction and information creation methodologies and techniques defined in Phase I and package them into a commercially viable product.

POTENTIAL COMMERCIAL MARKET: Commercial industries utilize past designs for new electronic product endeavors. With time to market and cost issues critical for global competitiveness, the methodologies, techniques and tools developed during this effort will be applicable to design reuse for many commercial applications.

REFERENCES:
1. Joel M. Schoen, Performance and Fault Modeling with VHDL, Prentice Hall, 1992.

END OF TOPIC

POINT OF CONTACT: Bill Russell, (513) 255-7371, russellwe@ml.wpa

AF97-196 TITLE: <u>Three-Dimensional Semiconductor Substrate Inspection</u>

OBJECTIVE: Develop and demonstrate methods of three-dimensional (3D) inspection of semiconductor wafers.

DESCRIPTION: State-of-the-art wafer processing is only as good as the quality of the starting substrate materials. As technology has greatly reduced the size of active components and allowed the integration of vast amounts of circuitry on a chip, the starting material quality has become a major variable in determining the final yield of a product. Not only is it important to have high wafer surface quality, it is equally important to have substrate crystal uniformity; i.e. defect free beyond the depth of the junctions of the active devices.

PHASE I: Develop 3D wafer inspection concepts for various substrate materials. Downselect the concepts to the one that has the greatest potential for inspecting the variety of substrate materials. Feasibility of the concept must be sufficiently proven.

PHASE II: Develop the selected concept, design and fabricate a prototype system to 3D inspect wafers. Demonstrate the effectiveness of this inspection system by processing a suitable device with wafers from a baseline inspection system and wafers inspected by the 3D system. Compare the yields and report the results. This demonstration task should be performed on at least two different material types such as bulk silicon, silicon on insulator (SOI), and Gallium Arsenide.

POTENTIAL COMMERCIAL MARKET: The product is valuable to the semiconductor industry to improve fabrication yields and reduce overall costs.

END OF TOPIC

POINT OF CONTACT: Michael Marchiando, (513) 255-2644, marchima@m

AF97-197 TITLE: Predictive Activity-based Cost Modeling Agent Network (PACMAN)

OBJECTIVE: Develop and demonstrate a tool for activity based cost modeling based on autonomous agents.

DESCRIPTION: Activity-based costing (ABC) has become popular among both financial and operational managers as a mechanism for understanding the sources of manufacturing related costs. ABC is based on the concept of tracking costs related to the activities that generate them, and not on the traditional categories of labor, materials, overhead, etc. Effective use of ABC allows heightened visibility into the true cost drivers associated with a manufacturing enterprise. The ability to model and forecast costs within the context of an ABC accounting system has potential to allow manufacturers to more effectively manage their resources and be more responsive in an ever changing market environment. Currently, ABC is used to track costs as they occur and not to model or forecast them. With the advent of powerful, inexpensive computing and object oriented programming, the ability to model and simulate complex systems using collections of simple, autonomous software agents operating in parallel has become feasible. The purpose of this effort is to explore the use of autonomous software agents to represent various manufacturing cost activities defined within an existing ABC system, and use this modeling capability to effectively forecast manufacturing costs.

PHASE I: Phase I of this effort will consist of a detailed analysis of a subset of ABC cost activities, and description, analysis and initial coding of software agents representing these activities and the relationships between them. Phase I will culminate with the development of an initial concept feasibility demonstration of an ABC cost forecasting tool based on Autonomous Agents.

PHASE II: Phase II will focus on the continued development, refinement, demonstration and implementation of ABC cost forecasting software based on Autonomous Agents. This Phase will culminate with the release of at least a beta version software modeling tool based on appropriate generic ABC activities.

POTENTIAL COMMERCIAL MARKET: Accurate manufacturing cost modeling and prediction is critical to all large scale manufacturing operations. Activity based costing is also finding demand in industries such as banking, utilities, retail, grocery, etc. Companies are trying to determine exactly where the cost for a particular brand or product comes from. Activity base costing enables this breakdown.

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1. Roberts, M.W., and K.J. Silvester, "Why ABC Failed and How

It Might Yet Succeed," RPM Group and Rensselaer Polytechnic published in the Journal of Cost Management, Winter, 1996.
2. Cohen, P.R., M.L. Greenberg, D.M. Hart, and A.E. Howe, "Trial by Fire: Understanding the Design Requirements for Agents in Complex Environments," AI Magazine 10:3 (Fall)34-48.

END OF TOPIC

POINT OF CONTACT: Ronald C. Stogdill, (513) 255-8589, stogdirc@m

AF97-198 TITLE: Innovative Manufacturing Technology Concepts

OBJECTIVE: Develop and demonstrate innovative approaches in advanced manufacturing technology concepts which have broad applicability to AF weapons systems.

DESCRIPTION: The Manufacturing Technology Directorate aggressively pursues advances in manufacturing technology which have broad applicability to the affordability and performance of AF systems. The focus of this general topic is to allow opportunities for major breakthroughs in the following areas: Composites Processing & Fabrication, Electronics Processing & Fabrication, Metals Processing & Fabrication, Advanced Industrial Practices, and Manufacturing & Engineering Systems. New processing techniques, variability reduction tools, affordability improvements, manufacturing simulation & modeling, are a few examples of the types of proposals that are desired. The emphasis is on innovation, the ability to achieve major advances, and defense/commercial applicability.

PHASE I: During Phase I, the offeror shall determine the technological merit and feasibility of the proposed innovative concept.

PHASE II: The Phase II effort is expected to produce a well defined deliverable product or process.

POTENTIAL COMMERCIAL MARKET: Each proposal submitted under this general topic should have an associated commercial/defense related application of the planned technology. The commercial application should be formulated and developed during Phase I. Phase II will require a complete commercialization plan.

END OF TOPIC

POINT OF CONTACT: Marvin Gale, (513) 255-4623, galeml@ml.wpafb.a

AF97-199 TITLE: Weapon Flight Mechanics Research

OBJECTIVE: Develop innovative concepts for advanced weapon airframes and navigation, guidance and control.

DESCRIPTION: New and innovative concepts for the area of air delivered conventional munitions and armament is sought. The Weapon Flight Mechanics Division conducts research and directs exploratory development of advanced weapon airframe concepts and the guidance, navigation and control (GN&C) of weapon airframes. Weapon airframes under consideration include air-to-air missiles, air-to-surface munitions (general purpose bombs and hard target penetrators), submunitions, and projectiles. Areas under consideration for weapon airframes include aerodynamic shaping, folding fins and wings, carriage and release technologies (especially multiple carriage and release of submunitions), and innovative control techniques (i.e. reaction controls, body bending, etc.). Areas of primary interest in navigation include very small low cost inertial measurement units (IMUs), Global Positioning System (GPS) guidance, jam resistance GPS, and transfer alignment. Areas of interest in guidance technology include optimal guidance law development, target state estimators and advanced adaptive autopilots.

PHASE I: During Phase I, the offeror shall determine the technological or scientific merit and feasibility of the innovative concept. The merit and feasibility should be clearly demonstrated during this phase.

PHASE II: The Phase II effort is expected to produce a well defined deliverable product or process.

POTENTIAL COMMERCIAL MARKET: Each proposal submitted under this general topic should have an associated dual-use commercial application of the planned technology. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan.

END OF TOPIC

POINT OF CONTACT: L. B. Simpson, (904) 882-8265, simpson@eglin.a

AF97-200 TITLE: Advanced Flight Controls for Small Airframes

OBJECTIVE: Develop a technique using advanced non-aerodynamic controls, such as reaction controls, to allow incremental translation maneuvers of small, high speed airframes.

DESCRIPTION: Large, conventional aerodynamic control surfaces not only add to the weight of an airframe, but also its cost. When the advantage of extremely accurate aimpoint selection provided by the global positioning system (GPS) is maximized, flight control devices must enable precise maneuverability. The use of reaction controls aids in countering target location error, assists in the terminal guidance phase, eliminates the weight of conventional control surfaces, and reduces package size and cost.

PHASE I: Phase I of this project should determine the feasibility of controlling a 250-400 pound, 5-7 inch diameter, 70-100 inch length vehicle through a prescribed set of flight maneuvers representative of a hard target penetrator weapon.

PHASE II: Phase II would require the development of a six-degree of freedom (6DOF) simulation of such a weapon. Limited ground tests of representative reaction control hardware, as well as wind tunnel tests of the airframe, are required to produce data for the simulation models.

POTENTIAL COMMERCIAL MARKET: Any aircraft can experience in-flight control system failures. If mechanical control surfaces fail on a small aircraft utilizing this type of alternate control philosophy, a blending of aerodynamic and propulsive flight controls may result in the pilot having some control over an otherwise uncontrollable aircraft. Some aspects of propulsive flight control technology may also be applicable to space vehicles.

END OF TOPIC

POINT OF CONTACT: L. Bruce Simpson, (904) 882-8265, simpson@egli

AF97-201 TITLE: Tactical Kinematic GPS/IMU Algorithms

OBJECTIVE: Develop methods to investigate and evaluate use of Kinematic GPS/IMU algorithms in a tactical munition dynamic environment.

DESCRIPTION: A need exists to improve navigation accuracy of Global Positioning System (GPS) guided munitions. Kinematic GPS uses carrier phase information that greatly improves the accuracy capability of GPS systems. However, high dynamic kinematic GPS navigation is limited by the ability to resolve the carrier integer cycle ambiguity in a timely manner. Ongoing efforts to develop more accurate IMU's (0.1 deg/hour) that are smaller and cheaper can be exploited to enable high dynamic kinematic GPS algorithms resulting in sub-meter GPS navigation accuracy.

PHASE I: Phase I of this project should investigate innovative high dynamic kinematic GPS/IMU algorithms tuned for the high dynamic environment of a tactical munition.

PHASE II: Phase II should be the realization via procurement/fabrication of a breadboarded kinematic GPS/IMU system tuned for the high dynamic environment of a tactical munition.

POTENTIAL COMMERCIAL MARKET: The commercial airline industry plans to use GPS as a primary navigation device. Thus, the FAA is very interested in accurate automated landing systems.

END OF TOPIC

POINT OF CONTACT: Mr Eddie Gibbs, (904) 882-5489, gibbs@eglin.af

AF97-202 TITLE: Multiple Sensor Inertial Measurement Unit

OBJECTIVE: Develop the filter for an Inertial Measurement Unit (IMU) utilizing multiple lower performance, low cost gyros and accelerometers and produce an inexpensive IMU with higher performance.

DESCRIPTION: There has been a constant demand to make tactical grade Inertial Measurement Units (IMUs) smaller, less expensive, and more accurate (Many of these factors are interdependent). The goal of this topic is to acquire greater accuracy from lower cost, less accurate sensors by using several of them per axis and then filtering their outputs to obtain lower errors than the single sensor method. A trade off will exist between the number of sensors and the accuracy gained per size increase, therefore, an accuracy improvement versus size/cost model must be developed. The end product will be a miniaturized filter and electronics package used to construct a multiple sensor per axis IMU. The size of the gyros and accelerometers is not relevant, however, once the sensor technology has matured, MicroElectroMechanical (MEM) sensors should be excellent contenders.

PHASE I: Phase I will consist of an analysis to determine the optimal number of sensors used to maximize performance and minimize size and cost. A computer simulation must be developed to demonstrate the performance improvement obtained when using multiple sensors rather than a single one. The simulation must include the development of the filter algorithms used to process the output of the multiple sensors, as well as depict the design for the filter, electronics, and the packaging. To demonstrate filter potential, single and multiple sensor accuracy for one axis must be tested and documented.

PHASE II: Phase II will develop and fabricate an IMU consisting of multiple sensors per axis, sensing electronics, and the sensor filter. The unit will minimize the package for the electronics and sensor filter without regard to sensor size, however, sensor quantity will be optimized. Single and multiple sensor per axis performance must be tested and documented.

POTENTIAL COMMERCIAL MARKET: Applies to almost all applications which use inertial sensors.

END OF TOPIC

POINT OF CONTACT: Lt Timothy Jorris, (904) 882-2961, jorris@egli

AF97-203 TITLE: Guidance Research

OBJECTIVE: Develop innovative concepts in guidance technologies

DESCRIPTION: The Advanced Guidance Division of the Wright Laboratory Armament Directorate seeks new and innovative ideas/concepts in several areas: Electrooptical, millimeter-wave, and radio-frequency seeker technology and the components and signal processing systems used in these seekers. This includes, but is not limited to, sources, detectors, polarization-sensing elements and systems, modulators (both single element and pixelated), pattern recognition and processing systems, and basic material and device development for accomplishing all of these; Polarization-sensing elements and systems for studies of the utility of such systems for target characterization and discrimination; Developing algorithms for use within autonomous target acquisition (ATA) applications; Innovative signal and image processing algorithms used, for example, in synthetic-aperture radar (SAR), millimeter-wave (MMW), infrared (IR), and laser radar (LADAR) are needed to autonomously detect and recognize target signatures embedded in sensor data; Operations/functions associated with the ATA process involve noise elimination, detection, segmentation, feature extraction, classification, (i.e., truck vs. tank), and identification (i.e., truck A vs. truck B); Algorithms capable of processing multi-sensor data are of particular interest; The utilization of image algebra in the development of non-proprietary ATA algorithms; Key research areas include signal and image processing, pattern recognition/classification, image understanding, artificial neural networks, fuzzy logic, superresolution, knowledge- and model-based vision, and data fusion. Concepts must have a good dual use/commercialization potential.

PHASE I: During Phase I, the offeror shall determine the technological or scientific merit and the feasibility of the innovative concept.

PHASE II: The Phase II effort is expected to produce a well defined deliverable product or process.

POTENTIAL COMMERCIAL MARKET: Each proposal submitted under this general topic should have an associated dual-use commercial application of the planned technology. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan.

END OF TOPIC

POINT OF CONTACT: M. F. Wehling, WL/MN, (904) 882-4032, wehling@

AF97-204 TITLE: <u>Optical Detection and Discrimination Techniques for Laser Radar</u>

OBJECTIVE: Develop alternative detection and discrimination techniques useful for 3D range-imaging and/or range-doppler imaging with an emphasis on low-cost and manufacturable technologies.

DESCRIPTION: Laser range-imagers and laser radars are useful tools for a variety of applications such as remote-sensing, machine-vision, parts inspection, and others. Most existing laser radar systems rely on one of two schemes for finding the distance to an object; either a pulsed detection scheme which measures the photon-time-of-flight or a coherent detection scheme which measures the radio frequency beat noise of two interfering optical signals. Generally, these systems operate with a single element detector (or a linear array of such elements) combined with a scanning laser beam to assemble an image. Each of these systems has several drawbacks which limit their applications, particularly in areas where cost is a concern. Current direct detection systems tend to have limited range resolution (inches) and are often limited by background noise, while current coherent systems tend to be complex and expensive. The use of a scanner limits the data rate of the system and the environment in which it can be used. The area searched by a system is limited by the required resolution and the data rate of the system. Although these two basic design concepts dominate the laser radar field, several variants of these systems and other system concepts are feasible. The goal of this topic is to develop laser radars based on techniques which promise a substantial performance improvement and/or cost reduction. Approaches which can improve the range or angular resolution are of interest. Systems which rely on previously unexploited optical properties (such as wavelength dependent properties) are also of interest. One possible example is to use modern solid state technology to implement low cost coherent systems. An additional example is to use modulation of the transmitted pulse to simplify/improve detection and or increase resolution.

PHASE I: Phase I of this project would demonstrate the applicability of the detection technique to specific problems in a controlled environment.

PHASE II: Phase II would consist of the construction of a fieldable laser radar system which operates on the principles demonstrated in Phase I.

POTENTIAL COMMERCIAL MARKET: This project would add new capabilities in the laser radar field that would benefit both commercial industry and the military, particularly in areas where current systems can not be used or are prohibitively expensive. A low-cost coherent system would be useful for

structural fatigue studies on large buildings and structures. A system with improved range resolution would enable automated parts inspection for manufacturing, and have possible medical applications for the measurement of burns and incisions.

END OF TOPIC

POINT OF CONTACT: Capt Kenneth Dinndor, (904) 882-1726, dinndor@

AF97-205 TITLE: Narrow Bandwidth Near-Infrared Tunable Optical Filter

OBJECTIVE: Develop a high-throughput optical filter with a line-width of 1 nm or less and tunable in the near-to-mid infrared.

DESCRIPTION: Optical bandpass filters are used in a variety of devices to reduce optical background noise near particular wavelengths of interest. Reduction of the optical noise increases the system signal-to-noise ratio, thereby increasing the probability of detection and accurate measurement of a given event. While high-performance compact narrowband filters are available at some specific wavelengths in the visible and near-infrared, there are currently no tunable filters available with equivalent size and performance. Recent advances in tunable laser technology make the development of high-performance tunable filters highly desirable. Currently, there are a few techniques which are used to filter tunable radiation; however, few of these have the size or performance required by our applications. For instance, monochrometers can be used to produce a tunable filter with a fairly narrow optical bandwidth; however, they are large, not particularly rugged, and generally do not have a very high throughput. In this project we are interested in producing a device which can be used as a tunable filter. The desired performance parameters are: tuning range from 1.5 microns to 2.5 microns, full width half maximum (FWHM) bandpass of 1 nm or less, greater than 70% in-band throughput, and greater than 40 dB rejection of out of band signals. This overall device size should be small enough to be incorporated into fieldable optical systems, i.e. comparable or smaller than existing components such as detector assemblies, optical isolators, etc. Additionally, the device should be able to operate over a wide temperature range without elaborate temperature control requirements.

PHASE I: Phase I of this project will investigate and demonstrate candidate techniques for developing compact tunable optical filters with the above performance goals.

PHASE II: Phase II would involve the fabrication, characterization, and packaging of the filters based on the techniques demonstrated in Phase I. The filters will be deliverable items.

POTENTIAL COMMERCIAL MARKET: This project would fill a gap in current filter capabilities that would benefit both the military and commercial industry. A tunable optical filter is required for several applications which have been enabled by recent advances in tunable laser technology. The compact size of this technology will allow the transition of techniques currently being explored in the laboratory into fieldable and commercially viable systems. One potential application of this

technology is highly-accurate hand-held chemical and pollution sensors.

END OF TOPIC

POINT OF CONTACT: Capt Kenneth Dinndor, (904) 882-1726, dinndor@

AF97-206   TITLE: High Performance Pulse Capture Circuitry for Near-Infrared Optical Receivers

OBJECTIVE: Develop, design and construct pulse capture circuitry with high sensivity, wide bandwidth, and large dynamic range.

DESCRIPTION: Recent advances in the field of imaging laser radar have resulted in compact and rugged lasers capable of producing high-quality, short pulses of light. One of the principal challenges to the field use of this technology is the lack of corresponding high-quality receivers. The receiver is needed to convert the returned optical energy to an electrical signal usable by digital circuitry and is generally composed of an optical detector, amplification and discrimination electronics, and an analog-to-digital converter. One challenge to the design of these receivers is the very large dynamic range required; the returned signal falls off as one over R-squared (best case), where R is the range to the object being imaged, and this problem is exacerbated because the reflectance from various objects can range from less than 1% to greater than 99%. A second challenge is the desire to time the arrival of the returned optical energy to greater than 1 ns accuracy, although transmitted pulse lengths are often longer than 10 ns. This requires implementation of pulse discrimination techniques in the receiver. While it is possible to obtain receiver systems which have either high sensitivity, wide-bandwidth, low-noise, or large dynamic ranges; suitable combinations of these desirable characteristics in a single receiver are not currently available. This limits overall performance for an application since systems must often be optimized for a particular region of the desired operating space. Detectors, such as avalanche photodiodes (APDs), are now available which can simultaneously fulfill many of these requirements; however, these detectors are useless without the appropriate electronics to capture and convert the optical signals into electrical signals usable with conventional digital circuitry. It is desirable to have electronics which can capture both the temporal and intensity information from an event with high accuracy over the desired dynamic range. Currently, there are no commercially available electronics packages which can support the desired operating range. The goal for this project is to develop receiver electronics which can accurately capture the intensity of an optical pulse with a dynamic range of at least 5 orders of magnitude and convert this pulse to a digital signal with high accuracy. The dynamic range must start from the minimum detectable signal from the detector. For purposes of initial design, a commercially-available InGaAs APD detector can be assumed. The electronics must be able to detect the pulse arrival with a minimum accuracy of 1 ns for optical pulse lengths from 1 ns to 20 ns

in length. The electronics must be able to properly control the bias of the detector and must be reasonably resistant to interference from other electronic components typically used in laser radar systems.

PHASE I: Phase I of this project should include designing the electronics circuitry and demonstrating the critical elements of the electronic design.

PHASE II: Phase II would consist of the construction and hardening of prototype receivers based on the technology developed in Phase I. A working receiver system will be delivered at the end of this phase.

POTENTIAL COMMERCIAL MARKET: This project would extend the field of the laser applications by increasing the robustness and useful operating range of fieldable systems. This technology would be useful in applications where both a high responsivity and a fast response time are required. Examples of such applications include spectroscopy, remote sensing, LIDAR, and fiber optics communications.

END OF TOPIC

POINT OF CONTACT: Capt Kenneth Dinndor, (904) 882-1726, dinndor@

AF97-207 TITLE: Advanced Processing Techniques for Restoration and Superresolution of Imaging Sensors

OBJECTIVE: Develop innovative and computationally affordable signal/image processing algorithms for image restoration and resolution improvement (superresolution) for smart weapon applications.

DESCRIPTION: The detection, acquisition, classification, identification, and aim point selection of tactical ground mobile, and high value targets are critical issues for smart weapons. The sensor resolution is dependent on aperture parameters and operating frequency. While it's true that the larger the aperture, the better the resolution will be, aperture size is constrained by the missile airframe. Spatial resolution varies proportionally with target distance. To be able to acquire a target at a reasonable range in a high clutter environment, or low signal-to-noise within an aperture-limiting hardware platform, advanced signal/image processing techniques are required. Wright Laboratory's Armament Directorate is interested in innovative signal/image processing techniques to perform image restoration and superresolution for smart weapon applications. Proposed efforts should offer the potential to improve the resolution of a variety of imaging sensors, and enhance target acquisition and classification performance in high clutter environments. Image restoration is essentially accomplished within the system's spatial frequency passband. Superresolution is a technique that recreates the frequency components not present in the image. Superresolution of image data requires bandwidth extrapolation in addition to passband restoration and consequently needs nonlinear processing techniques. Active radar, synthetic aperture radar, and interferometry are all inappropriate for this Research and Development effort.

PHASE I: The Phase I effort will consist of a conceptual study of advanced signal/image processing for image restoration and resolution improvement of images taken by various imaging sensors such as Imaging Infrared (IIR), laser radar (LADAR), or passive millimeter wave (PMMW).

PHASE II: Software development based on the conceptual study of Phase I will be demonstrated against measured and/or simulated data provided by the sponsor. The software must be developed on hardware platforms compatible with sponsor platforms. The software product will be installed on the government hardware platforms. The software documentation/user manual and the final report will be delivered to the sponsor at the end of the program.

POTENTIAL COMMERCIAL MARKET: This technology can be used in medical image enhancement and restoration; law enforcement

photo enhancement (for identification purposes); space imaging applications; global terrain mapping; and collision avoidance in air and ground transportation.

END OF TOPIC

POINT OF CONTACT: Sengvieng Amphay, (904) 882-4631, amphay@eglin

AF97-208 TITLE: Data Fusion Using the Wavelet Transform, Fractal Theory, and Statistics

OBJECTIVE: Develop a method for characterizing ladar intensity signatures using the wavelet transform, fractal theory, and/or statistics.

DESCRIPTION: The intensity data of a laser radar (ladar) pulse may be extracted when the range data is computed. It would be advantageous to use intensity data to augment the range data to improve automatic target identification (ATI) algorithm performance. Ladar intensity data is not currently being used in ATI algorithms because its inherent characteristics are not thoroughly understood (e.g., speckle fluctuations, aspect dependency, variations associated with range to target as well as atmospheric and weather conditions). These characteristics make it difficult to compare intensity data to some physically meaningful quantity. If the basic characteristics of intensity signatures are identified and a steadfast method of characterizing them is achieved, it is anticipated that the intensity data will provide an indispensable way of distinguishing dissimilar textures. This, in turn, will allow target signatures to be distinguished from background terrain and clutter thus improving detection, recognition, classification, and identification capabilities for autonomous algorithm performance. From previous studies of infrared/ladar sensor data, several mathematical methodologies have shown promise as a means for characterizing intensity data. These methodologies include the wavelet transform, fractal measure theory, and statistical theory.

PHASE I: The purpose of this program is to investigate the use of wavelet transforms, fractal measure theory, and statistical theory in formulating a real-time algorithmic fusion technique for ladar range and intensity data. During Phase I, current and past research efforts relevant to the theoretical development of wavelet transforms, fractal measure theory, and statistical theory as well as pertinent signal/image processing applications will be identified. These techniques will then be evaluated to identify those capable of distinguishing target intensity signatures from clutter, countermeasures, and background information. This will involve developing computer models of the various mathematical methodologies, generating databases of the respective intensity signature characteristics, and defining a set of unique characteristics that will augment information provided by the range data.

PHASE II: During Phase II the successful fusion algorithms formulated under Phase I will be used to develop ATI algorithms for seeker systems capable of acquiring ladar range and intensity data. The associated cost benefits of the methodology will be indentified. This will be achieved through algorithm performance analysis (false alarm rates; target

detection, classification, and identification probabilities) and real-time implementation analysis (data throughput, processor requirements).

POTENTIAL COMMERCIAL MARKET: These algorithms will have utility in conduction studies of the earth's resources using ladar data from satellites.

END OF TOPIC

POINT OF CONTACT: Karen Norris-Zacher, (904) 882-3910, norrisk@

AF97-209 TITLE: Armament Research

OBJECTIVE: Develop innovative concepts in areas associated with air deliverable munitions and armament.

DESCRIPTION: We need new and innovative ideas/concepts and analytical methodologies in the area of air delivered non-nuclear munitions, that have a dual use/commercialization potential. Products include bombs; submunitions; warheads; projectiles; fuzes (including safe and arm devices); explosives/energetic materials; time delayed, self degrading explosives; genetic engineering of molecular explosives; polymer binders for shock survivable explosives; structural technologies; fiber optics; solid-state inertial components; exterior ballistics; lethality/vulnerability and performance assessment techniques; test technology; modeling and simulation resources and techniques; and conventional weapon environmental demilitarization and disposal techniques. Some examples of desired research are target detection sensors; warhead initiation; self-forging fragment warheads; shaped charges; long-rod penetrators; reactive fragment warheads; computational mechanics (including interactive grid-generation techniques, and warhead hydrocode-assessment techniques); and hard-target weapon/penetration technology end energetic materials.

PHASE I: During Phase I, the offeror shall determine the technological or scientific merit and feasibility of the concept.

PHASE II: The Phase II effort shall provide a deliverable product or process.

POTENTIAL COMMERCIAL MARKET: Each proposal submitted under this general topic should have an associated dual-use commercial application. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan.

END OF TOPIC

POINT OF CONTACT: Dr. Norm Klausutis, (904) 882-2141, klausutin@

AF97-210 TITLE: Expendable, Low Cost, Solid State Millimeter Wave Components

OBJECTIVE: Develop small, expendable, low cost, solid state millimeter wave components. Include a complete description of research materials and processes.

DESCRIPTION: Low cost components serve as the prime design driver in all developmental expendable short range sensors regardless of the optimum operational frequency for the application. Ideally, many short range sensor designs would use the 60 - 110 GHz band of operation if low cost, miniature, expendable components were available. Advantages include antenna size, directionality, and reduced man-made noise sources. Output power levels of +10 dBm would be more than adequate for most intended applications if low cost, miniature, components were available.

PHASE I: Phase I efforts would examine materials, processes, and fabrication techniques for producing millimeter wave sensor components listed in the objective.

PHASE II: Phase II of the program would emphasize fabrication and packaging of several devices for performance testing by the Air Force.

POTENTIAL COMMERCIAL MARKET: Possible areas of commercial application include liquid level sensors, intrusion detectors, collision avoidance systems, "intelligent" vehicles, wireless communications, and space communications.

END OF TOPIC

POINT OF CONTACT: Robert Orgussar, (904) 882-2005, orgusaar@egli

AF97-211 TITLE: Infrared Fisheye Optics

OBJECTIVE: Develop, design and construct Infrared Fisheye lenses for fuzing sensors and fuzing test equipment video cameras.

DESCRIPTION: Recent advances show that very wide-angle imaging sensor proximity fuzes can significantly enhance warhead lethality. A key component for such sensors is the optical front-end which may consist of one or two fisheye lenses projecting images onto focal-plane detector arrays. At this time there are no known fisheye lenses in infrared bands, and typical visible band designs exhibit undesirable image compression near the edge of the Field-of-View (FOV). The focus of this effort is to explore the possibilities and limitations of customized fisheye lens designs for the infrared spectrum using optical materials suitable for high supersonic flight regimes and of visible-band customized fisheye lens designs intended for target position truth instrumentation.

PHASE I: Phase I of this project should investigate fisheye lens designs for the infrared bands of 3-5.5 microns, 5.5-7.5 microns, 8-12 microns and the visible band. The designs should achieve uniform magnification over the 180° FOV and will otherwise be optimized for minimum size, low ratio of focal length to aperture diameter, minimum internal reflections and number of elements given notional resolution requirements. Infrared-band designs shall consider materials suitable for operation with missile flight aeroheating and will be scaled to fit available focal plane detector array geometries and notional tactical size requirements. Two prototype visible-band fisheye lenses matching government furnished equipment (GFE) instrumentation video cameras shall be produced.

PHASE II: Phase II would involve scaling infrared fisheye designs to fit available non-developmental item forward looking infrared (NDI FLIR) cameras, constructing and evaluating fisheye lenses of the selected designs for all three identified infrared bands.

POTENTIAL COMMERCIAL MARKET: This project concerns efficient capture of very wide angle imagery with uniform magnification. Advances in this field could lead to low-cost wide-angle imaging sensors for many applications ranging from security cameras to robotics control to transportation (aircraft, marine and automotive) collision avoidance and protection systems.

END OF TOPIC

POINT OF CONTACT: Donald Cunard, (904) 882-2005, cunard@eglin.af

AF97-212 TITLE: Penetrator Communication Link

OBJECTIVE: Develop a shock hardened communication link capable of relaying penetrating weapon fuze data.

DESCRIPTION: A need exists for a shock hardened communication link capable of relaying penetration weapon fuze data. The communication link must be capable of surviving and transmitting the fuze data during or after the actual penetration event. The fuze data to be transmitted includes, but not necessarily limited to: Command and control signals between fuzing modules located at various positions within a multiple-event warhead/agent defeat weapon system; or deceleration data from an on-board accelerometer, fuze logic states, and a pre-fire pulse for bomb damage assessment (BDA) information. The communication link internal to the warhead must either be capable of surviving the penetration event or the communication link must not depend upon the survivability of a "hardware link."

PHASE I: Phase I will consist of a requirements study to assess the technology baseline for achieving a shock hardened communication link, and the development of a conceptual design(s). This phase will establish the concept(s) for internal weapon system communication between fuzing modules, weapon-to-weapon communication between fuzing systems, and weapon-to- surface communication capable of being received by an airborne relay.

PHASE II: Phase II will develop and fabricate a shock hardened communication link, or components, capable of relaying fuze data from a penetrating weapon. Static tests will be accomplished to demonstrate the ability to transmit the data through typical warhead media (e.g., simulated explosive material, simulated agent defeat chemicals, etc). The communication link components will be tested on a Very High G shock machine. The shock hardened communication link system will be tested in a subscale projectile from a 155mm Howitzer.

POTENTIAL COMMERCIAL MARKET: Mine and other subsurface communication applications.

END OF TOPIC

POINT OF CONTACT: Danny Hayles, (904) 882-2005, hayles@eglin.af.

AF97-213 TITLE: Pyrotechnic Initiator

OBJECTIVE: Develop, design and construct an igniter for various pyrotechnics capable of passing the safety requirements for use with in-line fuzes.

DESCRIPTION: Recent advances in the area of semiconductors and semiconductor processing have demonstrated the ability to fabricate a silicon sublayer that will vaporize under the action of a heavy current. The resulting plasma can be used to ignite a pyrotechnic material, which makes these devices suitable for use as igniters or detonators in explosive initiation. However these devices do not pass the safety requirements namely, the 500 V no-fire, and 1 amp/1 watt requirements for initiating sensitive pyrotechnics due to their susceptability to stimuli from external sources. This topic is intended to explore methods for fabricating a small semiconductor device with internal electrical components to allow it to stand off voltages below the 500 V limit (required for noninterrupted trains by MIL-STD-1901) and not function. Such a device will enable the item to be safe from accidental functioning without external electrical circuitry. The ability to fabricate the required components on a single silicon substrate will greatly enhance the versatility, lower the cost, and decrease the required volume. The Air Force applications include ordnance fuzing, munitions dispensers, rocket motor igniters, and actuators.

PHASE I: During Phase I, the offeror shall determine the feasibility of the proposed initiator, as well as develop a preliminary design and test plan.

PHASE II: The Phase II effort is expected to produce a well documented, tested, and deliverable initiator.

POTENTIAL COMMERCIAL MARKET: A safe igniter for primary pyrotechnics would be used most extensively by the automotive industry for air bags. Other uses are in the oil drilling and construction industries.

END OF TOPIC

POINT OF CONTACT: Steven Smith, (904) 882-2005, smiths@eglin.af.

AF97-214 TITLE: Hard Target Influence Fuzing Technology

OBJECTIVE: Investigate applicable technologies required for influence fuzing of hard target penetrators.

DESCRIPTION: Influence fuzing technology (i.e. acoustic, magnetic etc.) exists for detection and classification of heavy vehicles. However, the existing technology is not compatible with the desire to utilize large (up to 2000 lb) guided unitary weapons to inhibit vehicle traffic. The needed influence fuze technology must be capable of being contained within the existing 3 in. x 7 in. standard fuze well; surviving high speed impact into any media including rock and sensing vehicles out to the bomb crater radius from a buried position. The hardened components shall be capable of sensing heavy equipment such as trucks, earth movers and locomotives to prevent clearing of weapons.

PHASE I: Phase I of this project will study applicable magnetic and acoustic sensor mechanisms and necessary hardening techniques for a hard target attack capability. The study and analysis will also assess the sensor's influence due to heavy machinery through a thick steel case such as the BLU-109/B bomb body and determine approaches to increase sensitivity such as deploying sensors or antennas once the warhead is at rest. A trade study shall be made of survivability versus function/capability to determine the most applicable sensors and concepts including a preliminary design of the influence fuze.

PHASE II: Based on the results of the analysis and preliminary design in Phase I, selected sensors shall be hardened and concepts tested/verified for function and survivability during laboratory shock testing, field cannon testing through concrete targets and influence testing against heavy equipment.

POTENTIAL COMMERCIAL MARKET: This program will develop hardened sensors applicable for use in deep and sub surface mining and down-hole drilling.

END OF TOPIC

POINT OF CONTACT: Scott Teel, (904) 882-2005, teels@eglin.af.mil

AF97-215 TITLE: Munition Instrumentation and Performance Assessment Technology

OBJECTIVE: Develop new (revolutionary) instrumentation technologies and methodologies for analysis of data.

DESCRIPTION: a) Innovative ideas are sought for instrumentation to serve the very harsh, transient nature of munitions development and test. Specific requirements exist for: flexible, high capacity, rechargeable battery technology for powering subminiature munition telemetry packages; high power, 100 mw, continuous laser technology that can produce long coherence lengths, 2M, to reconstruct pulsed ruby laser produced holograms; high speed multiplexer technology that will enable image data to be read out from high resolution, high speed infra-red focal plane arrays. b) Performing an assessment of a new weapon concept requires inputs of factors such as target location and vulnerability, warhead lethality, guidance package precision, weapon flight profile, aircraft loadout. Current methods are mostly ad hoc and analyst driven. Research is sought for both conventional and innovative analytical methods to optimize existing personal computer based munitions effectiveness tools and develop new or more effective methodologies.

PHASE I: a) Phase I will include analytically evaluating the feasibility of the proposed concept, investigating alternatives, developing the concept through a design, and documenting proof of principle hardware that will be developed during Phase II. A demonstration of the concept using simple breadboard components is very desirable. b) Proposed analysis models will be investigated to arrive at technology choices. Existing models may be adapted or entirely new approaches may be investigated. A recommended methodology suite, including code requirements will be described.

PHASE II: a) Phase II will be used to develop, fabricate, and test an experimental version of the concept. Sponsor may provide access to actual munition experiments for validation purposes. b) Analysis codes recommended in Phase I will be implemented

POTENTIAL COMMERCIAL MARKET: a) By its very nature, instrumentation has high application potential for commercial uses and industrial processes. As examples: low profile, high current density batteries are needed in consumer devices such as camcorders and cell phones; lasers with long coherence lengths are required for 3-D large display holography and non-destructive test interferometry; and high speed multiplexor technology will support high resolution machine vision cameras for production lines. b) User friendly, PC-environment assessment codes would be a highly marketable product for any R&D organization. Commercial users would include mining and

drilling, and industrial safety organizations.

END OF TOPIC

POINT OF CONTACT: Mr. Robert N. Webb, (904) 882-3160, webb@eglin

AF97-216 TITLE: Electronic Imaging Transient Stereo Photogrammetry

OBJECTIVE: Develop stereo imaging sensor/illumination technology with "pulsed light" spatial/temporal gating capability.

DESCRIPTION: Ultrahigh speed diagnostics of conventional blast phenomena are presently based on rotating mirror/prism mechanical cameras. For experimental advanced munitions research, random access to events is required. Current high speed cameras require start up and synchronization, and, as a result, the cameras must trigger the experiment rather than capture random events. Current cameras only provide a sequential record, with no provision for indeterminate delays between events. Sample rates from 100,000 to 5 million frames-per-second are needed to cover the range of applications for detonation research. Advanced sensor/image intensifier/pulsed laser technology could lead to a random access electronic imaging solution for asynchronous capture of 8 to 10 high resolution images at up to 5 million frames-per-second. Research is required to enable film quality resolution (megapixel) at nanosecond or less exposure times with current generation fast image intensifier tubes. Potential approaches include multi-pulse lasers/multi-rod lasers with pairs of gated high resolution CCD cameras and electronic stereo displays. Modeling and simulation will be used to determine requirements such as power, pulse width, wavelength, and optical geometry. This project will also include proof of concept fabrication of the most promising technologies and experimental investigation of a proposed architecture.

PHASE I: Modeling, simulation, and the design of the "camera" to incorporate the technology will be included in Phase I. A proof of concept experiment with an explosive event would be highly advantageous to demonstrate the technical approach.

PHASE II: Phase II will include the design and fabrication of the sensors and support electronics necessary to demonstrate sensitivity, resolution and frame rates of the prototype system as compared to current ultra-high speed film cameras.

POTENTIAL COMMERCIAL MARKET: This technology would greatly benefit commercial explosives research, laser physics, spectroscopy, and auto safety research.

END OF TOPIC

POINT OF CONTACT: Mr. Donald R. Snyder, (904) 882-3160, snyder@e

AF97-217 TITLE: Blast and Ballistic Loading of Structures

OBJECTIVE: Develop physics-based models to simulate the response of structural elements subjected to high amplitude, short duration loading(s).

DESCRIPTION: Engineering models which accurately describe the response of ground-fixed structures to extreme loading conditions are needed. The technical challenge is to be able to accurately capture the essential features of the structural and material response using a physics based approach without having to resort to finite element/finite difference techniques. Areas of research interest include source term modeling of blast and shock, explosive casing breakup to include fragment characterization and subsequent transport, and blast and fragment synergism. Analytical models which simulate the interaction of these source terms with internal structural components are also required. Ultimately, the individual models will reside in a flexible, consistent, and modular overall end-to-end methodology.

PHASE I: Phase I proposals should clearly define objectives, approach, and payoffs for the innovative model concept. Although being exploratory in nature, the proposals should also address follow-on implementation concepts for modeling the response of hardened structures to high amplitude, short duration loading.

PHASE II: During Phase II the concepts developed during Phase I will be implemented in a modular assessment, PC or work station based format, user friendly environment. Unique features of the physics model based analysis methodology will be documented.

POTENTIAL COMMERCIAL MARKET: Proposals submitted must have an associated commercial application potential, such as prediction techniques for building demolition and safety-related assessments.

END OF TOPIC

POINT OF CONTACT: Mr. Benjamin T. Plen, (904) 882-4652, plengeb@

AF97-218 TITLE: <u>Non-Intrusive, Remote Identification of Chemical Contaminants</u>

OBJECTIVE: Develop technologies to remotely detect and identify environmentally damaging residue from munitions development and testing.

DESCRIPTION: Conventional munitions contain a variety of materials which could be hazardous to the environment. These materials include explosives, electronic components, plating materials, heavy metal alloys, as well as hazardous chemicals associated with the aforementioned. When munitions are tested at military land test ranges, some of the chemical and explosive residues remain in or on the soil, some may be deposited on the surface of vegetation, and some is dispersed into the atmosphere. Conventional identification and mapping of the exact contaminated areas is a costly and time-consuming process. The inability to quickly and efficiently map contaminants potentially limits use of test ranges due to closing large test areas as a safety measure when contamination occurs during testing. As an example of a remote, non-intrusive detection capability, a radar using extremely short pulses has been used to penetrate soil and detect the interface between soil layers. If such a non-intrusive technique could be developed to detect chemical contaminants in the soil using specific properties of the contaminants, identification of contaminated areas could be rapidly accomplished. This is not an effort to detect underground buried objects nor is it intended to develop one technology to identify all environmental contaminants. We are looking for innovative methods and technologies that will address specific remote sensing capabilities for contaminants related to conventional munitions research and testing.

PHASE I: Phase I is intended to explore and evaluate existing remote detection and identification technologies for their potential use in detecting environmental contaminants. This phase will also include the evaluation of chemical, heavy metal, and other environmental contaminants to determine specific properties that would lend themselves to detection using innovative applications of existing sensor technologies. Using these evaluations, candidate technologies for remote sensing applications will be recommended, and a program plan for exploiting these technologies in Phase II will be developed.

PHASE II: This phase will include developing and demonstrating new technologies, applications, or further refinements of existing technologies to solve the stated problem. Experiments will be performed that will demonstrate the ability to remotely detect and identify chemical and/or heavy metal contaminants in soils. The cost effectiveness of the sensor technology will be analyzed.

POTENTIAL COMMERCIAL MARKET: The commercial world would be interested in a technology that could sense and detect the presence of chemicals or heavy metals without taking core samples. The benefit would be safer, faster, and less costly assessment of contaminated areas.

END OF TOPIC

POINT OF CONTACT: Mr. Don D. Harrison, (904) 882-2203, harrison1

AF97-251 TITLE: Mission Area Requirements Managements

OBJECTIVE: Develop an information management tool and a database system for managing Air Force mission area requirements.

DESCRIPTION: Air Force operational commands currently develop and assess weapon system requirements through a mission area planning process. This process considers the need to operate and sustain current systems and to concurrently improve and replace them in response to changes in national strategies, threats and military missions. The Air Force Materiel Command (AFMC) needs ready access to these requirements and to the increasingly sophisticated and detailed prioritization, justification, historical and technical data that support them. These requirements data consist of written text and graphical representations of concepts, functional linkages, systems integration, specifications, measures of effectiveness and benefit assessments. Innovative process methodologies and tools are required to develop, attribute, coordinate, exchange, link, and trace these data among the Air Force commands and to closely relate them to new system and technology development efforts. The proposed process and office tools must take advantage of in-place processes and data systems and provide a fully functional capability to agencies where few automated processes or systems exist. The system must be compatible with existing office automation equipment and be capable of being operated and maintained by currently assigned personnel. It must demonstrate the ability to reduce the workload and time needed to produce and coordinate the required documentation and must provide feedback and linkage at all stages of requirements, systems and programming support to equipment now in use, new systems being developed and the science and technology efforts of industry and military laboratories.

PHASE I: Define and develop processes and a federated database system architecture that will allow automated exchange of detailed requirements information among user commands and AFMC. Demonstrate feasibility and utility of an enterprise system of databases by developing exemplary exchange protocols, rationalizing and closely linking the requirements information from one operational command to the research and development planning data at the Aeronautical Systems Center's Aerospace Control Technical Planning Integrated Product Team (TPIPT).

PHASE II: Using the Phase I demonstration results, develop the metrics for measuring effectiveness and collect data from the development and operational commands to plan implementaion of a fully integrated and interoperable data-based requirements management system within the US Air Force. Develop a complete set of requirements information exchange protocols and implement an automated requirements information exchange system among the Air Force headquarters, AFMC and Air

Force operational commands.

POTENTIAL COMMERCIAL MARKET: Industry will be able to utilize this system to trace Defense requirements to national objectives as well as tracing their concept proposals to specific, quantifiable Defense requirements. This information system will provide direct access to system requirements and supporting rationale at a level of detail, automation and integration not previously possible. Direct industry links are envisioned as a logical extension of this federated information system. Additionally, it will provide a directly transferable/usable process model and tool set for management of new business development and technology investment in the commercial sector.

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END OF TOPIC

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AF97-252 TITLE: Airborne Monitoring of Ground Vehicle Motion

OBJECTIVE: Develop methods of detecting and maintaining track of ground vehicles during their periods of travel and rest.

DESCRIPTION: Airborne radars are capable of detecting both stationary and moving ground targets. Stationary targets can be detected with high resolution Synthetic Aperture Radars (SARs), while moving targets can be detected and tracked with Moving Target Indicator (MTI) radars. However, joint SAR/MTI operations are needed to detect and maintain continuous track of subject vehicles which intermittently travel and rest. Our ability to meet this goal is currently frustrated by the limited ability of SARs to distinguish stationary targets of interest from background clutter; and by the limited ability of MTI radars to distinguish moving targets of interest from other background traffic, particularly in regions of high-traffic density.

PHASE I: Identify concepts by which airborne radars can locate and maintain continuous track of vehicles of interest, in motion and at rest, over long periods of time. Show the feasibility of implementing the concept with current and/or advanced technologies.

PHASE II: Design a system to implement the concept derived in Phase I. Develop the key technologies needed to implement the design.

POTENTIAL COMMERCIAL MARKET: This research could yield important results for the military and commercial sector. The detection, identification, and tracking of critical mobile targets (such as mobile missile launchers, artillery, etc.) is of major importance to the military. Similarly, the detection, identification, and tracking of civilian vehicles is needed in support of border patrol, counter-drug enforcement, and counter-proliferation. For these activities we need to be able to monitor subject vehicles over long periods of time. The ability to observe the origins, destinations, and travel routes of suspect vehicles would be immensely valuable for identifying illegal activities and for rapid apprehension of the offending parties. The commercial sector would produce the radars, the airborne platforms (aircraft or lighter-than-air craft) to carry the radars, and the computer hardware/software to implement the desired detection and tracking system.

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END OF TOPIC

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AF97-253 TITLE: Assessing Environmental Impacts on the Life Cycle of a System

OBJECTIVE: Develop a methodology and process to consider and analyze the environmental impacts throughout the life cycle of a weapon system.

DESCRIPTION: Both military and civilian system developers face the problem of design, manufacturing, maintaining, and disposing of systems while adhering to environmental laws, budgetary constraints and minimizing risks. Currently there are no accepted techniques, tools or valid metrics to treat the impacts or trade offs of hazardous materials (Haz Mat) on the life cycle of a system. A real vacuum exists in attempting to treat the Haz Mat problems during the early stages of a system concept. For example, Public Law 103-337, Section 815 requires analyzing as early in the process as feasible the life cycle environmental costs for major defense acquisition programs. A methodology, especially a quantitative one, that treats environmental impacts from system inception to system disposition is needed for both DoD and the commercial private sector.

PHASE I: Develop a prototype process for treating environmental effects on a weapon system (or commercial system), considering concept design, manufacturing, life cycle cost, and risk. Develop a prototype methodology and perform a feasibility demonstration.

PHASE II: Extend prototype into a working model, detailed process or toolset. Demonstrate the technique on an agreed-to-system concept to illustrate potential trade-offs while showing possible impacts on selected metrics including cost, schedule, performance and impacts on the environment.

POTENTIAL COMMERCIAL MARKET: Process, technique, computer model or tool kit will have direct application to the commercial sector or DoD.

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END OF TOPIC

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AF97-254 TITLE: Application of Genetic Algorithm to Optimization Problems

OBJECTIVE: Develop methods to demonstrate the utility of the genetic algorithm or other suitable machines that learn techniques to solve commercial and DoD problems.

DESCRIPTION: The ever increasing processing speed of modern digital computers make the application of genetic algorithm practical alternatives toward solving problems that require optimization of an objective function. The utility of these algorithms have been demonstrated to solve transportation and queuing problems. One possible use of the genetic algorithm is to apply it to evolve better tactics for air-to-air combat. Solutions to the problem have been solved only for simple cases such as one participant versus another (1vs1). Few solutions have been demonstrated at the many-on-many level (M vs N). One objective of this effort is to optimize one opponents' exchange ration (red kills/blue losses) while the other opponent is performing to the best of its ability. Real-time operation is not required.

PHASE I: Perform a proof of principle application of the genetic algorithm and demonstrate its utility by a demonstration.

PHASE II: Develop a detailed process, apply the genetic algorithm to a large scale M vs N air-to-air combat and write the necessary software to interface with selected Air Force air-to-air combat models.

POTENTIAL COMMERCIAL MARKET: Many commercial applications in the area of transportation, checkout lines and others, have been demonstrated. This could extend the realm of application to fields where the two sides react to each other including bio-medical fields.

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END OF TOPIC

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